MODULE 4: PREVENTING DISEASE INTRODUCTION & SPREAD

NATIONAL VETERINARY ACCREDITATION PROGRAM

United States Department of Agriculture • Animal and Plant Health Inspection Service • Veterinary Services

Approved as one unit of supplemental training for participants in USDA's National Veterinary Accreditation Program

the Center for Food Security & Public Health
Iowa State University

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National Veterinary Accreditation Program

Preventing Disease Introduction and Spread

This informational module has been approved expressly to serve as one unit of supplemental training for participants in USDA's National Veterinary Accreditation Program. The module is intended to familiarize accredited veterinarians with animal health regulatory concepts and activities. Information in the module does not supersede the regulations. For the most up-to-date regulations and standards, please refer to the Code of Federal Regulations or contact your local VS Area Office.

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This document was made possible, in part, by a Cooperative Agreement from the USDA-APHIS for the National Veterinary Accreditation Program. It was produced by the Center for Food Security and Public Health, Iowa State University of Science and Technology, College of Veterinary Medicine.

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Preventing Disease Introduction and Spread

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Preventing Disease Introduction and Spread

Introduction

Welcome to the Preventing Disease Introduction and Spread Module.

As an accredited veterinarian, one of your many roles and responsibilities is to ensure disease is not introduced or spread among animal populations. Veterinarians providing education about zoonotic diseases is another important responsibility. This can include instituting biosecurity protocols, proper disinfection procedures, and wearing appropriate personal protective equipment (PPE) when working with animals. This module will review concepts that are essential to prevent and control the spread of infectious disease agents.

After completing this module, you should be able to:

- Describe disease prevention practices that limit exposure to animals and humans
- Select job-appropriate PPE to minimize zoonotic disease exposure and fomite spread
- Implement appropriate cleaning protocols and select effective disinfectants
- Implement basic biosecurity practices for veterinary clinics, animal shelters, and livestock facilities
- Access additional resources for infection control practices including appropriate PPE selection

Completion of this module is estimated to take 55 minutes but will vary with your familiarity of the material presented.

Importance of Preventive Medicine

Accredited veterinarians are charged with the responsibility of safeguarding and protecting animal and public health. When an accredited veterinarian signs a Certificate of Veterinary Inspection or Health Certificate, they are certifying that when they inspected or examined the animals they were not showing signs of contagious*, infectious**, or communicable*** diseases. Increases in global travel, companion animal and exotic pet ownership, and the commercial production of food animals to feed our nation and the world have further necessitated the accredited veterinarian's role in preventive medicine.

*Contagious: capable of being transmitted from animal to animal.
**Infectious: caused by the entrance of organisms (bacteria, viruses, fungi, protozoa) into an animal which subsequently grows and/or multiples; infective
***Communicable: can pass or be carried from one animal to another directly or indirectly (fomites and vectors).

Preventing the exposure to pathogens is the cornerstone to disease prevention and enhanced animal health. Two terms are often used to describe disease prevention measures: Biosecurity and infection control. Biosecurity refers to the management practices designed to prevent the introduction of disease agents onto an animal facility. Infection control refers to the standard precautions designed to minimize transmission of zoonotic pathogens from animals to people.

Through implementation of well-designed biosecurity measures, we can help prevent or minimize exposure of animals to disease threats. Infection control measures can help protect ourselves, our staff, and our clients from zoonotic disease risks.

Accredited veterinarians can promote appropriate disease prevention and control strategies for their clients, their employees, and others involved in the animal health industry. Critical control points for preventing disease entry and spread in the clinic, in shelters, and on livestock operations will be covered in this module.

Preventing Disease Exposure

The first step in disease prevention is an understanding of disease etiology. In order for disease to occur, the triad of agent, host, and environment is necessary. For a disease agent to be transmitted from one animal to another it must first 'leave' the animal (route of transmission) and then it needs to 'enter' a susceptible animal (exposure route). For some diseases, the route of transmission and the exposure route are identical (shed or transmitted by aerosol and the susceptible animal is exposed via inhalation). For others, they are different (transmitted via feces and exposed via ingestion).

Since it is impossible to control all possible shedding (transmission) of disease agents, focusing efforts on limiting exposure wherever possible can help prevent disease.

The common disease exposure routes for animals and humans include aerosol/inhalation, direct contact, fomite, oral/ingestion, and vector-borne. Keep in mind that diseases may have multiple exposure routes and may be different for animals versus humans. Designing prevention practices aimed at minimizing exposure through these five routes, rather than aimed specifically at hundreds of individual organisms, is the approach that will be reviewed in this module.

Routes of Disease Transmission and Exposure

Aerosol

Pathogenic agents contained in aerosol droplets may be passed from one animal to another or between animals and humans. Most pathogenic agents do not survive for extended periods of time within the aerosol droplets, and close proximity of infected and susceptible animals is required for exposure. Appropriate ventilation and humidity control are management practices that can help limit aerosol exposure.

A few aerosol exposure disease examples:

- Canine distemper – dogs
- Feline panleukopenia – cats
- Infectious bovine rhinotracheitis – cattle
- Influenza virus – birds, pigs, dogs, cats, horses, human
- Pseudorabies (Aujesky's disease) – pigs, cattle, sheep, goats, dogs, cats
- *Sheep and goat pox – sheep, goats

*Foreign animal disease

Keep in mind that diseases can be transmitted by more than one route.

Direct contact

A susceptible animal or human becomes exposed through physical contact when the agent from an infected animal, human, or the environment enters open wounds, mucous membranes, or the skin through blood, saliva, nose-to-nose contact, rubbing, or biting another animal. Some disease agents can spread between animals of different species, as well as to humans. Isolating sick animals and preventing contact with susceptible animals will help limit direct contact exposure.

Reproductive is a type of direct contact exposure, specifically through venereal contact and in-utero. Ensuring the animals are test negative for disease(s) before breeding will help limit reproductive disease spread.

A few direct contact exposure disease examples:

- Brucellosis (various species) – cattle, dogs, horses, pigs, sheep, humans
- *Glanders (*Burkholderia mallei*) – horses, dogs, cats, sheep, humans
- *Monkeypox – rodents, non-human primates, human
- Parvovirus – dogs

- Q fever (*Coxiella burnetii*) – cattle, cats, dogs, sheep, goats, humans
- Rabies – all warm blooded animals including humans

*Foreign animal disease
Keep in mind that diseases can be transmitted by more than one route.

Fomite

A contaminated inanimate object (fomite) can transmit a disease agent from one susceptible animal to another animal or human. Fomites require a secondary exposure route (direct contact or oral) for the pathogen to enter the host. Examples include contaminated feed, needles, bowls/buckets, kennels, chutes, muzzles, and halters. Preventing fomite exposure relies heavily on proper cleaning and sanitizing/disinfection procedures for items used with animals.

Traffic is a type of fomite. A vehicle, trailer, or a human can carry organic material containing a pathogenic agent on tires, wheel wells, undercarriage, clothing, or shoes/boots to another location with susceptible species.

A few fomite exposure disease examples:
- Bovine leukosis virus – cattle
- Caprine arthritis and encephalitis – goats, sheep
- Cryptosporidiosis – cattle, dogs, goats, cervids, horses, cats, sheep, pigs, rodents, humans
- Equine infectious anemia – all equids
- *Nipah virus – pigs, horses, dogs, cats
- Ringworm – cattle, horses, sheep, goats, cats, dogs, humans

*Foreign animal disease
Keep in mind that diseases can be transmitted by more than one route.

Oral

Ingestion of pathogenic agents in contaminated feed, water or licking/chewing on contaminated objects can result in disease. Feed and water contaminated with feces or urine from other animals, including rodents and birds, are frequently the cause of oral exposure of disease agents. Contaminated objects (fomites) could include equipment, feed bunks, water troughs, fencing, salt and mineral blocks, and other items an animal may lick or chew. Preventing oral exposure involves isolating sick animals from susceptible animals, keeping feed and water clean by minimizing fecal and urine contamination, and keeping equipment clean.

A few oral exposure disease examples:
- Anthrax – cattle, sheep, goats, horses, pigs, dogs, cats, humans
- Johne's disease (*Mycobacterium avium ss. paratuberculosis*) – cattle
- *Escherichia coli* – cattle, horses, pigs, dogs, cats, humans
- *Campylobacter jejuni* – cattle, sheep, chickens, turkeys, dogs, cats, ferrets, non-human primates, humans
- *Foot-and-mouth disease – cattle, pigs, sheep, goats, cervids

*Foreign animal disease
Keep in mind that diseases can be transmitted by more than one route.

Vector-borne

An insect, usually an arthropod, acquires a pathogen from one animal and transmits it to another animal or human either mechanically or biologically. Vector control efforts focused on disturbing the source (egg laying areas, the use of larvicides) is often more effective than treating adults. Environmental controls (sprayers/misters, fly strips, insect bait) and topical products approved for animals are options to control some adult vectors.

Mechanical transmission: disease agent does not replicate or develop in/on the vector; it is simply transported by the vector from one animal to another (e.g., flies). A few disease examples include:

- Pinkeye (*Moraxella bovis*) – cattle
- *Screwworm myiasis – all warm blooded animals including humans

Biological transmission: vector takes up the agent, usually through a blood meal from an infected animal, replicates and/or develops it, and then regurgitates the pathogen onto or injects it into a susceptible animal or human (e.g., fleas, ticks, mosquitoes). A few disease examples include:

- West Nile virus (mosquitoes) – horses, dogs, cats, humans
- Plague (*Yersinia pestis*) (fleas) – cats, dogs, rabbits, rodents, humans
- *Rift Valley fever (mosquitoes) – cattle, sheep, goats, dogs, cats, humans
- Tularemia (tick) – sheep, cats, dogs, pigs, horses, rabbits, humans

*Foreign animal disease

Keep in mind that diseases can be transmitted by more than one route.

Managing Disease Exposure

Environmental contamination must not be overlooked as part of a disease management control program. Animals and people are often exposed to pathogens in the environment where they live or work. Many disease agents can survive for extended periods of time in soil, bedding, or other organic material. However, animals or humans acquire pathogens through one of the previously defined categories: inhalation (aerosol), ingestion (oral), direct contact, or via fomites.

Accredited veterinarians do not always know what 'awaits' them on the other side of the examination door or on the farm, so standard precautions to protect themselves, colleagues, staff, clients, and their animals are fundamental in minimizing exposure or spreading disease.

Knowledge Review #1

Each prevention practice below is designed to limit exposure through one or more routes. Match each prevention practice to its route(s). More than one route can be prevented by each practice.

A.	Preventing rodents from accessing feed storage areas	**1.**	Aerosol
B.	Isolating sick animals to an area with its own ventilation	**2.**	Direct Contact
C.	Cleaning and sanitizing esophageal tubes between uses	**3.**	Fomite
D.	Increasing the distance between infected and susceptible species	**4.**	Oral
E.	Using needles only once	**5.**	Vector-borne
F.	Spraying the area with an approved insecticide		

Answers are found in the appendix.

Minimizing Zoonotic Disease Risks

Zoonotic diseases are those transmitted between animals and humans under natural conditions. Human exposure occurs through one of the previously listed five routes of transmission (aerosol, direct contact, fomite, oral, and vector-borne). The elimination of all risks associated with zoonotic pathogens, especially in the veterinary profession, is not feasible. Wearing job-appropriate PPE is designed to limit or prevent exposure to infectious agents and could include one or more of the following: gowns, coveralls, laboratory coats, gloves, face shield, goggles, masks, and protective footwear. In some cases, PPE can help prevent reverse zoonoses, such as the wearing of masks to prevent aerosol exposure of respiratory disease agents to susceptible animals (e.g., 2009 pH1N1).

In 2008, the National Association of State Public Health Veterinarians (NASPHV) published the "Compendium of Veterinary Standard Precautions for Zoonotic Disease Prevention in Veterinary Personnel." The Compendium of Veterinary Standard Precautions provides guidelines for common sense infection control practices and also included a Model Infection Control Plan for veterinary practices to adapt and implement. The Compendium was updated in 2010.

Veterinary Standard Precautions

One of the main objectives of the Compendium of Veterinary Standard Precautions is to raise awareness of the scope of zoonotic disease risk in veterinary medicine. It addresses infection control issues and provides science-based infection control guidance. The Veterinary Standard Precautions (i.e., use of gloves, facial protection and protective outerwear) are intended to be used whenever exposure to potentially infectious materials, including feces, body fluids, vomitus, exudates, and non-intact skin, may occur.

The Compendium of Veterinary Standard Precautions is a free resource and available here: *http://www.nasphv.org/Documents/VeterinaryPrecautions.pdf*

Personal Protective Equipment (PPE)

The nature of veterinary practice includes well animal exams on a variety of species as well as treating sick, injured or immunocompromised patients. Zoonotic infectious disease situations may present themselves at the most unexpected time, so wearing some form of barrier protection for certain situations is warranted.

Barrier protection, also called **Personal Protective Equipment (PPE)**, includes items worn to protect the skin, mucous membranes, and respiratory system of personnel.

PPE is an infection control measure that can protect veterinarians, staff, and clients from zoonotic disease exposure. It can also help reduce transfer of microorganisms from humans (hands, clothing) to susceptible animals and thereby minimize the spread of pathogens in a clinic, between patients, or between livestock premises (biosecurity). Some disease agents (influenza virus, foot-and-mouth disease virus) can be harbored in the nasal passages of humans; to prevent spread to susceptible animals, avoiding contact is recommended until the agents are no longer viable (differs by organism).

For a detailed review of PPE, please see *NVAP Module 10: Personal Protective Equipment for Veterinarians*.

Knowledge Review #2

A new client has just brought in her 4 year old spayed female dog that is lethargic, anorexic, febrile, mildly dehydrated, and polyuric but up-to-date on all vaccinations. You want to collect blood for a CBC and chemistry panel. Without a diagnosis, what is the <u>minimum</u> amount of PPE that should be worn in order to protect yourself and any staff members handling the dog? Select ALL that apply.

- **A.** Lab coat or smock
- **B.** Gloves
- **C.** Disposable shoe covers
- **D.** Surgical mask
- **E.** Safety glasses

Answers are found in the appendix.

Engineering and Administrative Controls

While PPE is often thought of as the first level of protection from disease agents or injury, there are other controls that should be put in place whenever possible. These include engineering and administrative controls.

Engineering controls are measures that contain or remove hazards, or expedite compliance with safety procedures. Examples include providing hand washing facilities near animal handling areas, placing sharps containers near areas where needles and scalpels are used, and having isolation areas for sick animals. Administrative controls include designing the work to keep the individual separated from the hazard. An example is to prevent workers without proper training (animal restraint, medication administration) or preventive vaccinations (rabies, tetanus, influenza)* from participating in certain situations. This also includes proper training so that everyone can identify the hazards

(disease agent or pending injury) and are aware of safety policies to protect their own health and that of others. Veterinarians should lead by example in promoting safe work habits.

The Compendium of Veterinary Standard Precautions is an excellent starting point to learn more as well as *NVAP Module 10: PPE for Veterinarians*.

* Rabies vaccinations are recommended for veterinary personnel. Rabies titers should be assessed every **two** years and a booster rabies vaccine given when the titer is less than 1:5 per the rapid fluorescent foci inhibition test. Tetanus vaccinations are recommended every **10** years. Influenza vaccines are encouraged for personnel working with poultry, swine or ferrets to prevent human-to-animal transmission. See the CDC Advisory Committee on Immunization Practices (ACIP) for more information.

Hand Washing

Hand washing is the single most important thing you can do to minimize the risk of infectious disease spread. Gloves can help protect hands from becoming contaminated but they are **not** a substitute for hand washing.

Hand washing is a Standard Precaution that should always be done before and after all animal examinations and especially after contact with sick animals and contaminated surfaces. Given the nature of veterinary work, easy access to a source of running water, a soap dispenser, and paper towels will enhance hand hygiene which decreases disease exposure. Without access to running water, disposable wipes can be used to remove organic material from hands (it may take several).

If proper hand washing facilities are not available, and hands are not grossly contaminated, waterless disinfectants (60-95% alcohol) can be used. These products are highly effective against bacteria and enveloped viruses, but less so with non-enveloped viruses, bacterial spores, or protozoal parasites. For a review of diseases caused by viruses and bacteria, see the "Selected Viral Families, Viruses and Species Affected" and "Bacterial Group Review Table" in the appendix.

Preventing Needlestick Injuries

Some of the most frequent injuries in the veterinary workplace are due to needlesticks. These include puncture injuries* and inadvertent injection** with vaccines, antimicrobials, or anesthetic agents. Adverse effects range from local irritation to a serious systemic reaction. If a needlestick injury occurs during venipuncture or fine needle aspiration on an animal, there is risk of direct exposure to zoonotic pathogens. All needlestick injuries should be immediately washed with soap and water.

*Puncture injuries occur when the skin is broken with an uncontaminated needle and no injection occurs.

**Inadvertent injection. Vaccine adjuvants or product carriers in medications can be very irritating, and depending on the body location of the puncture, may require prompt medical attention. Human medical professionals may not be familiar with the products used in veterinary medicine, so ensure the injured person or first responder takes the bottle or product insert with them. This will expedite the most appropriate treatment to hopefully avoid fasciitis or loss of an appendage.

Methods to reduce the risk of needlestick injuries:

- Conveniently place an approved sharps container wherever animal care occurs
- Use proper animal restraint by trained personnel
- Do not remove or replace needle caps by mouth
- Use needle recapping techniques as described in the Veterinary Standard Precautions Compendium.
- Do not bend needles or walk with uncapped needles.

Additional Protective Actions

Besides hand washing and needlestick injury prevention, there are other protective actions that can be taken to prevent disease exposure:

- During patient examination, the use of proper restraint techniques (trained personnel, muzzle, rabies pole, livestock chutes) is crucial to protect personnel from bite/scratch/kick/crush injuries as well as protecting the patient from injuring itself.
- During procedures that can generate splashes (necropsy, lancing abscesses), sprays and/or aerosols (dental procedures), and those that may involve significant contact with body fluids (oral exams, rectal/vaginal exams) or mucous membranes, veterinary personnel should utilize PPE as well as proper instrument handling techniques.

Whenever the hazard can be removed, make that the first step in prevention (engineering controls). Next, ensure those involved are properly trained and aware of safety precautions (administrative controls). Then, ensure everyone with contact with the hazard wears appropriate PPE. These are things that practitioners can do every day to protect themselves, their staff, and their clients from exposure to zoonotic diseases. Done appropriately, these steps will also limit spread of contagious organisms to other animals.

Cleaning and Disinfection

Proper cleaning and disinfection is another important infection control step to minimize disease spread. Protocols and chemical selection may vary depending on the needs of the facility. No single disinfectant is adequate for all situations.

Consideration of the microorganism being targeted, the specific disinfectant characteristics, and the environmental conditions are important aspects of an effective disinfection protocol.

Some disinfectants can be harmful to humans and animals, so safety is always an essential consideration.

We will address all of these topics on the next few pages.

Cleaning

Cleaning alone can remove over 90% of microorganisms when done properly. Cleaning measures should be conducted prior to the application of all disinfectants.

Effective cleaning involves a 4-step process:

- Dry Clean
  Remove manure, bedding, gross debris, and other organic material. This is a crucial step. When performed correctly, this eliminates a large number of microorganisms present. It also allows disinfectants to work properly, since most disinfectants have reduced effectiveness in the presence of organic material.

- Wash
  Soak the area with water (hot, if available) and detergent, then wash by wiping, scrubbing, or spraying. Caution should be used with high pressure spraying; this method may further aerosolize microorganisms and contribute to disease spread. Pay special attention to washing floor drains and corners; these areas can serve as reservoirs for pathogens and should be cleaned last and disinfected last.

- Rinse
  Rinse all washed areas thoroughly. Many disinfectants can be inactivated by residual soaps and detergents.

- Dry
  Allow the area to dry before applying a disinfectant to reduce the dilution effect.

Cleaning and Disinfection Definitions

There are many terms used to describe products used for cleaning and disinfection (C&D). It is important to understand the benefits and limitations of the types of products to ensure effective products are used. Below are some of the more common terms.

Detergents are chemical products used to disperse and remove soil and organic material from surfaces by reducing surface tension and increasing the penetrating ability of water. This can improve a disinfectant's ability to reach and destroy microorganisms within or beneath the dirt. Some disinfectants (i.e., quaternary ammonium compounds) have detergent properties.

Soaps are anionic detergents, made by treating a fat with a salt (sodium or potassium). As a cleaning/washing agent, they can become excessively foamy, creating a residue.

Sanitizers reduce the bacterial population in the inanimate environment by significant numbers but **do not destroy or eliminate them all.**

Antiseptics reduce the risk of infection by killing or inhibiting the growth of microorganisms on **tissue**. Because these products are used in or on humans or animals, they are considered drugs and are approved and regulated by the U.S. Food and Drug Administration (FDA).

Disinfectants are substances used on inanimate surfaces that **destroy or eliminate a specific species** of microorganism, but are not usually effective against bacterial spores. Disinfectants are registered as "antimicrobial pesticides" and regulated by the U.S. Environmental Protection Agency (EPA). Disinfection can also be achieved by physical means (e.g., heat, ultraviolet radiation).

Sterilants are substances that **destroy or eliminate all forms of microbial life** in the inanimate environment, including vegetative bacteria, bacterial spores, fungi, fungal spores, and viruses. Sterilization can also be achieved by physical means (e.g., heat, ultraviolet radiation).

Knowledge Review #3

What percentage of microorganisms can cleaning alone remove? Select ONE answer.

A. 70%
B. 80%
C. 90%
D. 100%
E. Cleaning alone does not remove microorganisms, you need disinfection to remove microorganisms.

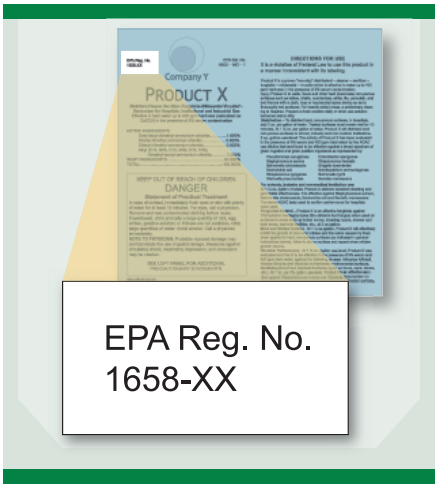
Answers are found in the appendix.

Product Registration and Regulation

Sanitizers, disinfectants, and most sterilants are registered by the U.S. Environmental Protection Agency (EPA) as "**antimicrobial pesticides**" and defined as substances used to control harmful microorganisms on inanimate objects and surfaces.

Data on a product's chemistry, efficacy, toxicity to humans, animals and plants, and other parameters must be tested and submitted to the EPA. Following EPA approval (and registration), a product may then be labeled as such and marketed.

Product labels will list an **EPA Registration Number** to show that the product has been reviewed by the EPA and can be used with minimal risk when the label directions are properly followed. For maximum success in preventing disease spread in a clinic, shelter, or livestock operation, only EPA registered products should be used.



Implementing a Disinfection Action Plan

The following are important steps in implementing a disinfection action plan.

Assess

Whenever possible, identify the infectious microorganism(s) suspected, exposure route(s), and the potential areas affected.

Clean

As previously described, the four steps include dry cleaning, washing, rinsing, and drying.

Disinfect

Selection of the proper disinfectant will depend on the microorganism(s) suspected (label claim), availability, as well as environmental factors (e.g., temperature, pH impact) and safety issues. **Always read the entire product label** and follow dilution instructions explicitly to ensure that the safest, most effective concentration is applied.

The disinfectant should achieve the appropriate contact time, followed by a thorough rinsing if the product label so directs. For some products, rinsing is very important, especially if animals will be returned to the area. The area should then be allowed to dry completely before animals are moved in.

Selecting an Appropriate Disinfectant

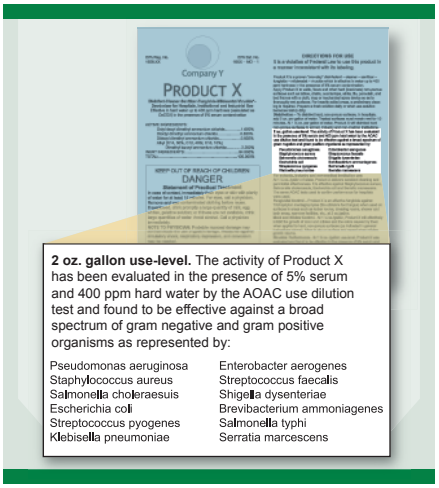
Selection of a disinfectant begins with the **identification of the target microorganism**. It is easier to select a product or protocol for a single microorganism, although this is not always possible in everyday practice.

If the organism has not been identified, or a disinfectant is needed for a wide range of organisms, a broad-spectrum approach should be utilized. Microorganisms vary in their degree of susceptibility to disinfectants.

The "Antimicrobial Spectrum of Disinfectants" handout in the appendix shows the susceptibility of microorganism classes to various chemical disinfectants.

Disinfectant Product Label

Understanding the information on a disinfectant product label is essential for developing an effective disinfection protocol. Factors such as microbial spectrum and efficacy, product uses, proper dilutions, contact times, and safety issues will vary among products.



Always read the product label before use! It is a violation of federal law to use a product in a manner inconsistent with its labeling.

Text from a sample disinfectant product label will be used in this module to demonstrate information provided on a product's label to help in decision making. For a complete review, see the "Disinfectant Product Label" document in the appendix.

Disclaimer: *The use of trade names in this material does not in any way signify endorsement of a particular product. They are only provided as examples.*

Label Claims

Label claims must be supported by efficacy testing. Three test microorganisms are used to determine Gram-positive, Gram-negative, and hospital-medical use designations.

- **Limited efficacy** is a claim of disinfection or germicidal activity against one specific microorganism group, either Gram-positive (*Staphylococcus aureus*) **or** Gram-negative (*Salmonella choleraesuis*). The label must specify the group against which the product is effective.
- **General-purpose or broad-spectrum** is a claim of effectiveness against both Gram-positive and Gram-negative bacteria. This claim must be supported by efficacy testing against *S. aureus* and *S. choleraesuis*.
- **A hospital or medical environment claim** must be supported by efficacy testing against *S. aureus* **and** *S. choleraesuis* **and** also the nosocomial bacterial pathogen, *Pseudomonas aeruginosa*.

Claims against pathogenic fungi or other microorganisms are permitted on the label following standardized testing procedures, but are not required by EPA.

Environmental Considerations

Environmental factors must also be considered when selecting a proper disinfectant and include:

- **Heavy soiling or organic load:** Organic material such as soil, manure, blood, or bedding can neutralize many disinfectants and protect micro organisms from contact with disinfectants.
- **Surface topography:** Porous, cracked, or pitted surfaces such as wood, rough concrete or earthen floors are difficult to disinfect and can harbor microorganisms.
- **Water hardness:** The presence of calcium or magnesium ions in "hard" water can inactivate or reduce the effectiveness of certain disinfectants (quaternary ammonium compounds, phenols).
- **Temperature:** Most disinfectants work best at temperatures above 68°F (20°C).
- **Effect on equipment:** Some disinfectants can be highly corrosive and will damage equipment.
- **Presence of other chemicals:** Interactions with other chemicals (e.g., soaps, detergents) or structural compositions (e.g., metals, rubber) can also affect a disinfectant's efficacy.

The activity of some disinfectants is also affected by pH, sunlight (ultraviolet radiation), relative humidity, and other factors.

Other Disinfectant Considerations

Other considerations when selecting a disinfectant include:

- **Application method:** Disinfectants can be applied in a variety of ways including wiping, brushing, spraying, misting, soaking, fumigating, etc.
- **Expense:** Calculate on a per gallon of use/dilution rather than the cost of concentrate.
- **Contact time:** The minimum contact time is normally stated on the product label; however, it is affected by the presence of organic matter, temperature, pH, water hardness, and disinfectant concentration.
- **Government regulations:** While the EPA registers products and approves them for use, it is important to be familiar with your local or state regulations for other restrictions. Contact your local or state environmental agency for more information.

Factors such as disinfectant concentration, stability and storage, and instructions for use must also be evaluated and understood to ensure safety for the user and efficacy against the organisms of concern. For more information, please refer to the "Characteristics of Selected Disinfectants" in the appendix.

Classification of Chemical Disinfectants

**Reviewers: This section is an interactive page for active learning on the web.

Disclaimer: The use of trade names in this material does not in any way signify endorsement of a particular product. They are only provided as examples.

Acids

Examples: Hydrochloric, peracetic, acetic, citric

Acids have a defined but limited use as disinfectants.

Acids are generally effective against vegetative bacteria; the hydrogen ion is bacteriostatic in the pH range of 3 to 6 and bactericidal when the pH drops below 3.

The efficacy of acids against bacterial spores is variable and limited, and often requires high concentrations such as 2.5% hydrochloric acid solution.

Concentrated solutions of acids can be caustic, cause chemical burns, and can be toxic at high concentrations in the air. If acidic disinfectants are used, personnel should, at a minimum, wear eye protection and rubber gloves during mixing, application, and rinsing.

Alcohols

Examples: Ethyl, isopropyl

Alcohols are considered fast-acting (no residual activity) and capable of killing most bacteria within 5 minutes. They are limited in virucidal activity.

The presence of water is necessary for alcohol efficacy to denature proteins. Therefore, concentrations of 60-90% are recommended. The effectiveness of alcohol disinfectants is limited in the presence of organic matter.

Alcohols may be used for surface disinfection; however, they evaporate rapidly making extended contact time difficult.

Alcohols are highly flammable, can cause damage to rubber and plastic, and can be very irritating to injured skin.

Aldehydes

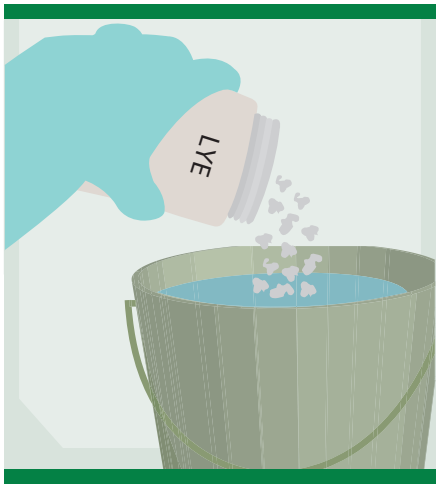
Examples: Formaldehyde, paraformaldehyde, glutaraldehyde

Aldehyde disinfectants are slow-acting but are very effective. They are generally non-corrosive to metals, rubber, plastic and cement. However, they are highly irritating and toxic to animals via contact or inhalation.

Efficacy of formaldehyde is dependent on relative humidity and temperature; optimum being humidity close to 70% and a temperature close to 57°F (14°C).

Formaldehyde is acutely toxic to humans and has been identified as a potential carcinogen. Appropriate PPE must be worn when using all aldehyde products.

Formalin is a 37% solution of formaldehyde in water.



Alkalis

Examples: Sodium or ammonium hydroxide, sodium carbonate

Activity is slow but can be increased by raising the temperature of the solution.

Alkalis are corrosive agents and PPE is essential when preparing or applying any of these agents. Sodium hydroxide (lye, caustic soda, soda ash) is used to disinfect buildings but is highly caustic and corrosive to metals. Always add lye to water; NEVER pour water into the lye. A very violent reaction will occur, producing heat that can melt plastic containers.

Biguanides

Examples: Chlorhexidine, Nolvasan®, Chlorhex®, Virosan®, Hibistat®

Broad antibacterial spectrum, but limited in their effectiveness against viruses and are not sporicidal, mycobacteriocidal, or fungicidal.

Function in a limited pH range (5-7) and are easily inactivated by soaps and detergents.

Toxic to fish and should not be discharged into the environment.

Biguanides are cationic compounds often used as a skin antiseptic and for preoperative skin preparation.

Halogens

Examples: Hypochlorites (sodium hypochlorite is household bleach) and iodophores

Broad-spectrum and often formulated with soaps making them relatively safe. Their antimicrobial efficacy is rapid, and halogens are not affected by water hardness.

Halogen products can lose their potency over time or at high temperatures. They are generally low in cost and relatively easy to use.

Halogens are extremely sensitive to organic material, so thorough cleaning must be done prior to application.

Halogens, especially chlorine, should NEVER be mixed with strong acids or ammonia as toxic gases can form. They are also highly toxic to aquatic animals, so discharge into watersheds or waterways must be avoided.

Sodium hypochlorite at low concentrations (2 to 500 ppm) is active against vegetative bacteria, fungi, and most viruses.

Sodium hypochlorite diluted to 5,000-6,000 ppm (1:10 bleach:water ratio) and corrected to pH7 through the addition of acetic acid can be an effective sporicide.

High concentrations of hypochlorites are irritating to the mucous membranes, eyes, and skin, and can cause damage to the footpads of animals.

Iodophores are iodine complexes that have increased solubility and sustained release of iodine (e.g., povidone-iodine).

Inactivated by quaternary ammonia compounds (QACs) and organic debris.

Concentrated iodine compounds can be irritating to the skin, stain clothes, or damage rubber and some metals.

Oxidizing Agents

Examples: Hydrogen peroxide, peracetic acid, Virkon® S, Oxy-Sept® 333

Broad-spectrum, peroxide-based compounds and relatively safe in their diluted form.

Hydrogen peroxide is rapid acting, however hydrogen peroxide solutions can break down quickly, so fresh solutions should be used. The desired concentration for hydrogen peroxide is (5-20%); home solutions are typically 3%.

Virkon® S (potassium peroxymonosulfate and sodium chloride) has some efficacy in the presence of organic material. Rinsing after the appropriate contact time is important before restocking with animals.

Concentrated solutions may be irritating and damage clothing.

Phenols

Examples: One-Stroke Environ®, Amphyl®, Lysol®, Tek-Trol®, Pheno-Tek II®

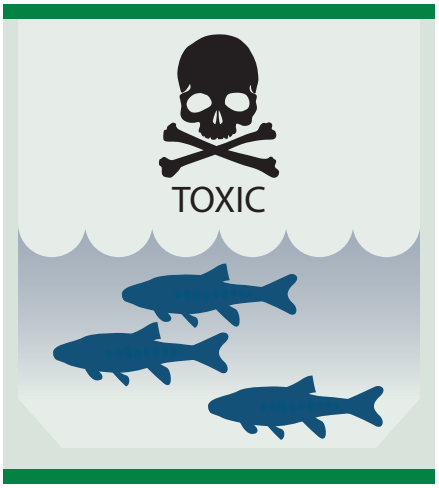
The antimicrobial activity depends on the formulation, but phenolics are broad spectrum and generally effective against many bacteria, mycobacteria, fungi, and enveloped viruses. Their efficacy against non-enveloped viruses is variable, and they have minimal sporicidal activity.

Can be coal-tar derivatives or synthetic formulations and usually have a milky or cloudy appearance when added to water, as well as a strong pine odor (e.g., Pine-Sol®).

Typically formulated in soap solutions to increase their penetrative powers.

Maintain activity in hard water, organic matter, and have some residual activity.

Prolonged exposure to the skin may cause irritation. Concentrations over 2% are highly toxic to all animals, especially cats (e.g., systemic toxicosis) and pigs (e.g., dermal contact lesions)



Quaternary Ammonium Compounds

Examples: Roccal®-D Plus, DiQuat, D-256®

Easily inactivated by organic matter, detergents, soaps, and hard water (this may vary with the "generation").

Not effective against non-enveloped viruses or mycobacteria.

Have some residual effect and lose their activity at pH <3.5.

Toxic to fish and should not be discharged into water sources.

Knowledge Review #4

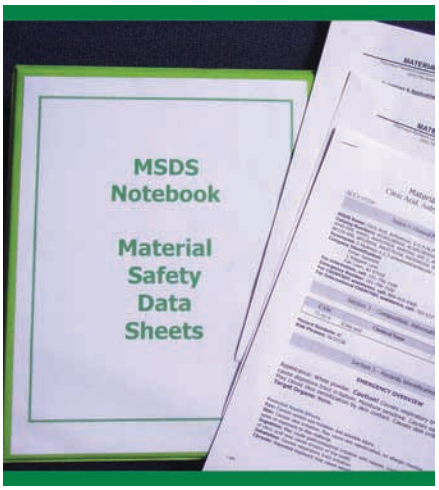
For daily use, when the specific microorganism could differ depending on the patient, a broad spectrum disinfectant is often selected. Which of the following classes of disinfectants are considered broad spectrum?

- **A.** Acids
- **B.** Alcohols
- **C.** Aldehydes
- **D.** Alkalis
- **E.** Biquanides
- **F.** Halogens
- **G.** Oxidizing agents
- **H.** Phenols
- **I.** Quaternary ammounium compounds

Answers are found in the appendix.

Safety Issues

The health and safety of humans and animals should always be a primary consideration when selecting a disinfectant. All disinfectants have some level of hazard associated with their use. Some pose a serious threat to human and animal health (e.g., sodium hydroxide, aldehydes, phenolics) if not handled appropriately. Careful attention should always be paid to the warnings and safety statements printed on a product's label.



All chemical disinfectants have a **Material Safety Data Sheet (MSDS)** listing the stability, hazards, and personal protection needed, as well as first aid information. This information must be kept on site and be available to all personnel handling disinfectants. A 3-ring binder containing this information in one easily accessible location is recommended.

Animal and Environmental Health

Some disinfectants cannot be used when animals are present or must be thoroughly rinsed away with potable water prior to restocking with animals. Many disinfection compounds are also known ecological hazards for plants and aquatic life (e.g. sodium carbonate, hypochlorites, phenols). Therefore, drainage, runoff, and biodegradability of disinfectants should be considered.

Personnel Safety

Most disinfectants can cause irritation to eyes, skin, and/or the respiratory tract. Some disinfectants may cause allergic reactions, such as allergic dermatitis, in personnel. The safety of all personnel handling or using disinfectants should always be addressed. Training on proper storage, mixing, and application procedures is essential. Standard PPE, including protective outerwear, gloves and in some cases, goggles/face shield (eye protection) or masks (respiratory protection), should be worn during the mixing or application of disinfectants. Read the product label and/or MSDS to determine if additional precautions (ventilation, respirators) should be implemented.

Evaluating Cleaning and Disinfection Efficacy

It is important to determine if the disease microorganism(s) has been eliminated, and also if the protocol used was effective and efficient. The best time to sample is immediately after the disinfectant contact time has elapsed or after the disinfectant has dried. Bacteriological samples may be obtained via moistened sterile swabs, Swiffer®, or gauze wipes. The samples can then be submitted for culture using various types of media. RODAC™ or Petrifilm™ plates may also be used. This is especially important while controlling an outbreak or a hard to eliminate organism in a clinic, animal shelter, or on a livestock operation.

RODAC™ stands for Replicate Organism Detection And Counting and are commercial plates used to sample the environment for organisms after a cleaning and disinfecting procedure has been implemented. The RODAC™ plate is incubated for 24-48 hours and the number of colonies are counted to determine organism presence in the area.

Petrifilm™ are ready made culture mediums used to grow microorganisms as a test to see how well the cleaning and disinfection procedure was implemented. Time and temperature of incubation varies with the plates and organisms being tested.

Knowledge Review #5

What factors should be taken into consideration when selecting an effective disinfectant? Select ALL that apply.

A. Smell
B. Safety
C. Availability
D. Label claims
E. Color
F. Cost
G. Environmental impact
H. Weather (temperature, humidity)
I. Surface texture

Answers are found in the appendix.

Implementing Biosecurity Principles

Disease entry and spread risks to veterinary facilities, animal shelters, and livestock facilities differ in scope, but overlap exists in the prevention principles that can be applied. Disease risk perception and tolerance also varies among individuals, so rather than providing a prescriptive plan to prevent disease introduction and spread, key concepts will be reviewed that can be applied to a variety of settings.

The goals of a well-designed biosecurity plan include:

- Creating an environment where animal care is optimized by reducing the threat of infectious and nosocomial disease
- Promoting infectious disease control practices among staff and clients
- Reducing the risk of zoonotic disease exposure and prioritizing public health among staff and clients
- Protecting the facility from liability and financial loss
- Maintaining client confidence in disease prevention

Next we will address key biosecurity topics for veterinary clinics as well as ambulatory and mobile practices.

Veterinary Clinic Biosecurity

Biosecurity protocols customized for an individual clinic should specifically address potential risk areas within that facility. An assessment of each area within the clinic will help to evaluate and characterize potential sources of exposure and areas needing improvement. Given the breadth of the audience, a mixed animal practice that provides services to small and large animals will be discussed. The areas to be reviewed include:

- Waiting room or patient receiving
- Holding facilities
- Livestock chutes and stocks
- Exam rooms
- Treatment and surgical preparation areas
- Isolation areas
- Inpatient facilities
- Boarding/shelters

Biosecurity protocols should be tailored for each area to minimize infectious disease transmission. These areas and some potential risks involved with each are discussed next.

Waiting Room or Small Animal Receiving Area

The **waiting room/small animal receiving area** should be clean, well ventilated, and large enough to avoid crowding of clients and patients. Walls, furnishings, and flooring (fomites) should be impervious and easy to clean and disinfect. Pathogens, such as parvovirus and leptospirosis, will expose other animals via the oral route with ineffective or untimely cleanup of feces, urine, or vomitus, or inadequate disinfection.

Animals should be required to be on leashes or in kennels to prevent direct contact with other patients in the waiting area. Additionally, to prevent disease transmission by any route, **animals appearing ill upon arrival should be immediately escorted to an exam room**. If this is not possible, the client should keep the animal in their vehicle (weather permitting) until one becomes available.

A buildup of patients in the waiting room may increase the potential for direct contact transmission. Appointments should be scheduled so that the capacity of the waiting room is not exceeded, thereby minimizing the potential for spread of infectious disease.

Holding Facilities

Holding facilities used for large animals brought to a veterinary clinic need to be designed and maintained to reduce the risk of disease transmission.

- Prompt isolation of patients presenting with diarrhea will help control the spread of pathogens found in feces (reduce risk of oral exposure).
- Animals exhibiting respiratory signs should be housed so that they are not sharing air space with other susceptible animals. This may be outside, away from others, or in an isolation pen with its own ventilation (reduce risk of aerosol exposure).
- Ideally, to decrease the risk of a variety of disease exposures, limit situations that lead to housing multiple animals with varying disease signs.

Contact surfaces should be non-porous and in good repair to allow thorough cleaning. Wood panels should be coated with a wood sealer to allow easy scrubbing and cleaning between patients. Pens should be cleaned, washed, rinsed, disinfected, and allowed to dry between different client's animals as a way to manage fomites.

Chutes and Stocks

Chutes or stocks used for large animal patients should be regularly maintained (rust areas sealed) to allow for more effective cleaning and disinfection after each use to prevent the fomite/oral transmission of organisms found in feces such as *Mycobacterium avium* ss. *paratuberculosis* (Johne's disease) or *Salmonella*.

- Placement over concrete flooring is preferred to dirt since the area can be washed down and disinfected.
  - Safe footing must also be a priority – slippery concrete is a concern if the surface is not adequately grooved or covered with non-slip and porous matting
  - Non-concrete flooring should factor in drainage and cleanability
- The stocks and surrounding area should be stripped of soiled bedding and all organic matter should be removed by soaking, then scrubbing with a brush and detergent.
- After cleaning, the area should be rinsed, dried, and then disinfected (allowing the appropriate contact time as per the label instructions).
- High-pressure washing can be the most efficient means to clean a large area. However, further aerosolization of infectious agents may occur and should be avoided if susceptible animals are housed nearby or PPE is unavailable for personnel.

Oral speculums, stomach tubes, tattoo and dehorning equipment, grooming supplies, balling guns, endoscopes, ultrasound probes and thermometers should be cleaned after each use to remove all organic material and then disinfected. Consider surface type and material composition when selecting a disinfectant so as not to damage the equipment.

Exam Room

Exam room surfaces that directly contact patients should be cleaned and disinfected after each use. Follow the recommended contact times for disinfectants used on surfaces. Too often surfaces are sprayed with the disinfectant in one hand and wiped with the other, not allowing for proper contact time. For patients with an infectious disease, this could lead to exposure of subsequent animals or staff if the pathogen is zoonotic.

- Equipment such as thermometers, otoscopes, and flea combs used in the exam room should be cleaned and disinfected between uses (reduce risk of fomite exposure)
- Disposable items can be used to minimize animal-to-animal disease spread if used once and properly disposed. (reduce risk of fomite/direct contact exposure)
- The use of wet mops or filtered vacuums on impermeable floor coverings can help to reduce the spread of aerosolized agents.

Ventilation systems with air inlets near the ceiling and air outlets closer to the floor are best for air flow since fresh air will travel down toward the more heavily contaminated floor region.

Each exam room should be outfitted with a sink with warm running water, soap dispensers and towels. All people having animal contact should be encouraged to wash their hands thoroughly between patients. There is a proper way to wash hands and a sign is provided below as a resource that can be posted near sinks. Hand sanitizers (60-90% alcohol-based) can be used after washing hands if desired. Hand sanitizers do not remove organic material and are not a substitute for hand washing. An example hand washing sign is provided in the appendix.

Surgery Room

The **surgery room** should be a separate, closed, single-purpose room dedicated to performing aseptic surgical procedures. The area should be uncluttered to minimize environmental contamination. Surfaces should be impervious so they can be thoroughly cleaned and disinfected. This should be a low traffic area, restricted to only the patient, necessary technicians or assistants, and surgeons. Proper attire including disposable booties, caps, surgical mask, sterile gowns, and surgical gloves is recommended to prevent fomite contamination of the patient from clothes and hands.

Positive pressure ventilation providing a controlled and filtered air supply will ensure that contaminated air is not drawn in from nearby rooms.

The use of separate wet mops, buckets, and cleaning supplies dedicated to the surgical suite can reduce the risk of infectious disease spread from other areas of the clinic (reduce risk of fomite exposure).

Isolation Area

An **isolation area** should be used for animals suspected of having, or already diagnosed with, an infectious, contagious or communicable disease.

Foot traffic within the isolation area should be restricted to essential personnel and should flow from "clean" to "dirty" areas. Always provide running water (warm if possible as it increases compliance) and soap for hand washing. Barrier protection (dedicated gowns, coveralls, or laboratory coats) should be provided and kept in isolation until removed in a sealed bag and immediately laundered. Protective footwear – disposable booties for small animals and disposable or rubber boots for large animals – should also be disposed of or kept in isolation. No items should leave the isolation area without proper cleaning and disinfection, or in sealed bags destined for proper disposal.

Separate airspaces are recommended for isolation wards or rooms. If only a single airspace exists:

- Limit new patient admissions to isolation
- Isolate the animal to one end of the barn or kennel room near the air outlet, and if possible, with empty stalls/cages around it
- Clearly mark the area or kennel with signage so all personnel recognize this animal is contagious and must be handled appropriately (reduce risk of fomite exposure)
- Keep respiratory cases in a separate room and prevent recirculation of air with the other areas of the clinic (reduce risk of aerosol exposure).

The use of separate mops and brooms, buckets, instruments, and protective clothing within the isolation area reduces the potential for spreading infection to the rest of the hospitalized patients.

Cleaning and disinfecting the isolation area is essential to minimize disease spread. Protocols must be established and personnel trained on how to remove organic material, dispose of it properly, wash/sanitize the area, rinse, disinfect and allow it to dry between patients. Often times the diagnosis of the patient is known, so select the best chemical disinfectant that will have efficacy against, and prevent further spread of, the organism.

To ensure no organisms are detectable, evaluate the effectiveness of the cleaning and disinfection protocols by collecting environmental samples (animal contact areas) and submitting them for a microbiological culture and identification or use RODAC™, Petrifilm™ or similar products.

Inpatient Facilities

Small animal kennels should be designed to prevent direct contact between patients and should be easy to clean and disinfect between animal uses to minimize the risk of fomite/oral/direct contact exposure. Food/water bowls and litter boxes should be cleaned and disinfected between animal uses as well (reduce risk of fomite, oral exposure).

Large animal inpatient facilities and equipment, including grooming tools, halters, instruments, waterers, and feeders, should be thoroughly cleaned and disinfected between patients to minimize the risk of fomite/oral/direct contact exposure. All contaminated bedding from pens/stalls should be removed prior to cleaning (reduce risk of fomite/direct contact/oral exposure).

Clearly written instructions (standard operating procedures or SOP) that detail proper cleaning and disinfection steps for inpatient facilities should be provided for staff.

Sinks with warm running water and soap for visibly soiled hands should be conveniently located for staff to use before and after patient contact. Hand sanitizers (60-90% alcohol-based) can be used after washing hands if desired but again, they do not remove organic material and are not a substitute for hand washing.

Other considerations for inpatient facilities include proper ventilation and vector control to minimize disease transmission.

Small Animal Boarding/Animal Shelters

Aerosol transmission of infectious agents in a susceptible population is dependent on temperature, relative humidity, ventilation, and animal density. Reducing disease transmission requires improving ventilation systems and increasing the distance of separation between infectious and susceptible animals.

Ventilation for dogs and cats should be aimed at minimizing odors, drafts, ammonia levels and moisture condensation. Fans, blowers or air conditioning should be provided when the temperature exceeds 85°F (29.5°C). When the areas are cleaned, the humidity levels often skyrocket. While veterinary clinics and animal shelters are not regulated under the Animal Welfare Act, its regulations provide benchmarks that have the animal's health and well-being at the forefront.

Source:

- *Animal Welfare Regulations, 9CFR, Subchapter A, Part 3, Subpart A—Specifications for the Humane Handling, Care, Treatment, and Transportation of Dogs and Cats, §3.2 Indoor housing facilities available at: http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&sid=996f89db5084e41d5aa58731ab931a84&tpl=/ecfrbrowse/Title09/9cfr3_main_02.tpl*

Cage design will affect air distribution. Solid side walls, floors and roofs with gated fronts leave only one area for intake and exhaust of air per cage. Work with a heating and cooling expert that can advise on site specific and energy conscious air exchange rates.

Large Animal Boarding

In barns housing large animals, air exchange rates are commonly recommended based on animal species, climate, size and construction of facility (solid versus slatted floor, wall height, ridge vents, etc.). Air distribution also helps minimize odors and humidity. Based on cubic feet per minute (cfm), some of the recommendations used to remove moisture and dilute or remove aerosolized pathogens are:

- Cold weather: sows 20 cfm/head, sheep/horses 25 cfm/head, mature cow 36 cfm/head
- Mild weather: sows 80 cfm/head, sheep/horses 100 cfm/head, mature cow 120 cfm/head
- Hot weather: sows 500 cfm/head, sheep/horses 335 cfm/head, mature cow 335 cfm/head

Source:

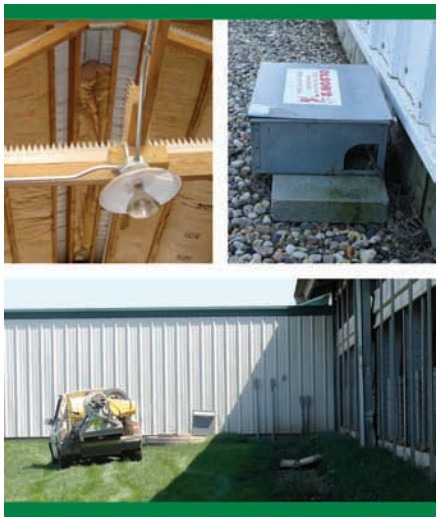
- *Livestock Housing Ventilation Fan Selection, The Ohio State University Extension available at: http://ohioline.osu.edu/aex-fact/0112.html*

Below are various resources with more detail about ventilating livestock housing facilities:

Horse Stable Ventilation, Pennsylvania State University: *http://pubs.cas.psu.edu/freepubs/pdfs/ub039.pdf*

Fan Performance and Efficiency for Animal Ventilation Systems, University of Minnesota: *www.extension.umn.edu/distribution/livestocksystems/DI0956.html*

Livestock Housing Ventilation Fan Selection, The Ohio State University Extension: *http://ohioline.osu.edu/aex-fact/0112.html*



Vector, Rodent, and Bird Control

Insect and pest control measures should be implemented when necessary. Each fly, for example, acting as a mechanical vector can carry 6,000 *Salmonella* organisms at one time. Fly strips or timed pesticide misters with products that are labeled for use in food producing animals may be helpful for clinic fly control. See the "Fly Control Measures" document in the appendix for more details. Mosquitoes and ticks also spread disease to animals and control measures are provided in their respective handouts in the appendix.

Rodents and birds should also be controlled as they can introduce and spread infectious disease. Focus on eliminating openings for entry, removing potential hiding or nesting spaces, eliminating food sources (sealed containers for pet

food, livestock feed), and proper disposal of garbage. Trapping and baiting are both options to control rodents that have entered facilities. More details are provided in the "Bird and Rodent Control Measures" in the appendix.

Outdoor Areas

Outdoor exercise and elimination areas for dogs can quickly become contaminated with feces and urine if not maintained appropriately. Impervious contact surfaces, such as concrete, are easier to clean and disinfect, but are not always possible in clinical practice. In any case, all feces should be removed in a timely manner and the area disinfected if possible. Personnel cleaning these areas should wear appropriate PPE, gloves at a minimum.

Physical disinfection, such as drying, heat and sunlight are natural disinfectants which can be used for pens, paddocks, and exercise areas with dirt floors and full sun exposure. Although many bacteria are killed by exposure to cold temperatures, freezing is not a reliable method of disinfection or sterilization; viruses tend to survive better at colder temperatures.

Knowledge Review #6

Once a parvovirus positive puppy is admitted to your clinic, what biosecurity protocols should be implemented to decrease the risk of spread? Select ALL that apply.

- **A.** Close off the exam room until it can be properly cleaned and disinfected
- **B.** Disinfect all contaminated areas with either a hypochlorite (halogen) or oxidizing agent
- **C.** Isolate the dog in an area with completely separate ventilation to prevent aerosol spread
- **D.** Provide barrier protection (gowns, gloves, disposable booties) and a dedicated trash receptacle near the puppy
- **E.** Remind staff to only use alcohol based hand sanitizers after handling the puppy

Answers are found in the appendix.

Ambulatory and Mobile Clinic Biosecurity

It is imperative that veterinarians who travel to a client's livestock operation or home consider the special circumstances surrounding biosecurity in these situations.

Fomite transmission is one of the principle concerns for the mobile veterinarian. This involves not only external contamination of a vehicle but also potential contamination of the internal compartment from clothing, equipment, etc.

Whether you drive a car, van, sport utility vehicle, truck, or a custom designed mobile clinic, specific biosecurity protocols should be adhered to in order to prevent infectious disease spread.

Vehicle – External

External cleanliness of the vehicle is important. Vehicles can serve as fomites, transmitting infectious organisms from one place to another.

Avoid driving through areas contaminated with animal waste. This is considered an engineering control (avoiding the hazard) on livestock operations. Organic material and manure can pack the tires and wheel wells of a vehicle and be carried long distances. An alternative is to park your vehicle in a clean area and take all necessary equipment with you, or use a client's vehicle that remains on the premises.

If driving through animal waste areas is necessary and the farm has a known or suspect fecal-shed infectious disease, the best management practice would be to clean (water and detergent) your tires, wheel wells, and vehicle undercarriage to remove all organic debris. Follow with a rinse then apply disinfectant to the tire contact surface and wheel wells and allow it to dry for best efficacy. Manage the run off so as not to contaminate the environment or waterways. If on-farm cleaning and disinfection is not feasible, go directly to a car wash facility before traveling to other livestock operations.

Although these steps may not always be convenient, in a foreign animal disease outbreak, each step would be imperative to limit disease spread.

Vehicle – Internal

The **internal cleanliness** and organization of vehicle compartments are very important in reducing the risk of disease transmission and spread. Items such as coveralls, gloves, boots, and equipment will likely have direct contact with animals; their storage location is important. If designated clean and dirty areas exist in the vehicle, cross-contamination can be minimized.

Establishing a clean and dirty area in the vehicle is essential to prevent disease transmission. This could be as simple as using the passenger seat for all "clean" items and the rest of the vehicle as "dirty".

An inexpensive option to minimize infectious disease spread in a vehicle involves the use of sealable plastic totes to establish "areas". Sealable plastic totes come in multiple shapes and sizes and make excellent storage for clean and dirty items.

Other advantages include:

- Easy to clean exterior
- Provides clean storage for coveralls, scrubs, gloves, palpation sleeves, etc.
- Tight seal protects contents inside from getting dirty
- Can be secured on the floor, back seat or in the trunk
- Contain dirty items, contaminated clothing or trash in one location
- Easy to "clean up" at the end of a day. Removal of the dirty container and its contents reduces the risk of mixing dirty with clean items

Similar containers can be used for shoe or boot covers as the photo depicts. Once cleaned with soap and water, protective footwear should soak in a disinfectant for an appropriate contact time (follow label directions for best efficacy). With plastic sealable containers, it is easier to make sure this happens between farm calls. Simply leave footwear in the disinfectant as you drive to the next call. The solution will not spill and footwear will no longer be a potential fomite.

Equipment

Equipment used on clients' animals, when cleaned appropriately, poses minimal risk of infectious disease spread. Certain equipment may be more difficult to clean and disinfect due to the type of material it is made out of or how it is constructed (ultrasound equipment, rope halters, obstetrical chains).

Multiple use items, such as surgical instruments, halters, or muzzles, should be properly cleaned and disinfected prior to use at another facility. This is essential to minimize the risk of disease spread. Disposable equipment, such as gloves, needles, syringes, and some scalpels are intended to be single-use to minimize animal-to-animal disease spread. A good disease control practice is to leave all garbage generated on a call at the source, allowing pathogens to remain where they originated. All sharps should be placed in a sharps container and properly disposed of.

Clean immediately after use.

Once a procedure is complete, washable items should be cleaned immediately since body fluids and organic matter are more difficult to remove once they have dried. If complete cleaning is not an option, rinse with water or soak, to prevent the fluids from drying and adhering, such as the castrator and dehorner soaking in the bucket of appropriate disinfectant in the photo on the right.

Disinfect or sanitize once organic matter is removed.
An appropriate disinfectant should be selected and used after the equipment has been cleaned. In some situations and for some equipment, a sanitizer should be used. Multi-dose syringes used for vaccine or antibiotic administration require special handling. Soaps and disinfectants can bind to the internal surfaces and inactivate modified-live vaccines. Please refer to the document, Care of Veterinary Vaccine Syringes produced by the University of Nebraska, Lincoln for specific cleaning guidance. *http://www.ianrpubs.unl.edu/epublic/archive/g1443/build/g1443.pdf*

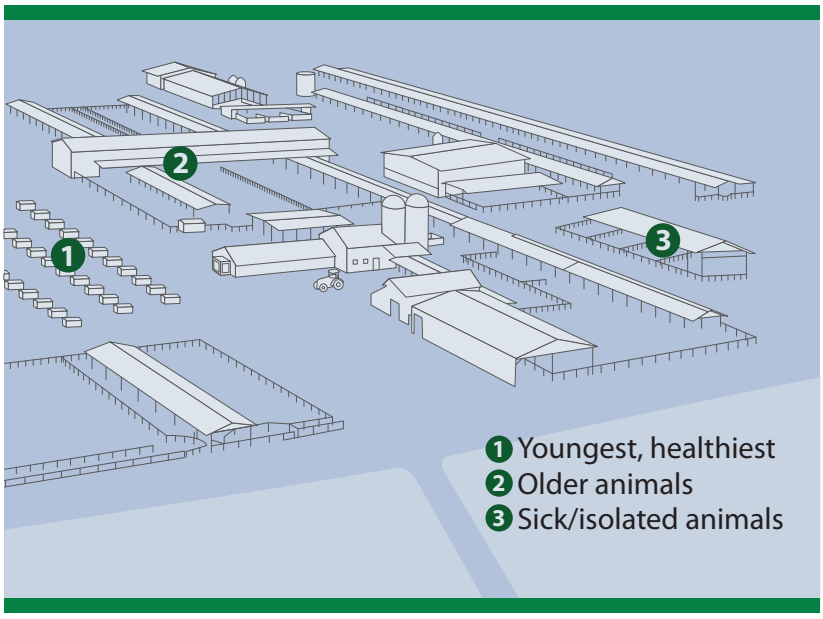
Store equipment in a clean area of the vehicle.
This will prevent contamination prior to the next use.

Examine equipment before use.
Due to the nature of mobile practice, items can become contaminated between uses. Thoroughly examine equipment for contamination before use. If equipment is dirty, don't use it until it has been cleaned and disinfected.

Wash your hands before leaving the farm.
The importance of hand washing cannot be overemphasized. Since access to running water and soap is not always convenient, carry disposable wipes to remove organic material from hands; it may take several depending on the procedures involved on farm. Hand sanitizers (60-90% alcohol-based) can be used after washing/wiping hands if desired. Hand sanitizers do not remove organic material and are not a substitute for hand washing.

On-Farm Infection Control Procedures

Ensure the farm visit does not introduce or spread disease through your actions. This begins by wearing the proper protective outerwear as a barrier to contamination of street clothes. Some operations may require showering before contacting the animals and wearing farm-specific clothing. Other operations may provide coveralls and protective footwear to wear while working with the animals. For farms that do not provide either, wearing clean outerwear/coveralls and footwear on each operation can prevent disease introduction.



As an effort to minimize disease spread on farm, examine sick animals last if possible. Start with the youngest, healthiest animals, working your way to the older animals, handling the sick or isolated animals last. If this is unavoidable, take time to clean and disinfect protective footwear or change into disposable boots when entering healthy or young animal facilities. Washing hands and changing out of contaminated outerwear should also occur between animal groups to prevent fomite exposure.

Knowledge Review #7

While examining a first calf beef heifer with a high fever, nasal discharge, and open mouth breathing, you want to look for oral lesions since she has a fetid breath odor. You properly restrain her and examine her mouth with a speculum. Despite no lesions, saliva and nasal discharge cover your skin and coveralls. What is the minimum "clean up" that should occur before leaving the farm? Select ALL that apply.

A. Wash the oral speculum in soap and water and return to its storage compartment in your vehicle.
B. Wash your hands, arms, neck and face with soap and water to remove the contamination.
C. Remove contaminated outer-clothing and store in the dirty part of your vehicle.
D. Clean and disinfect your boots

Answers are found in the appendix.

Summary

As accredited veterinarians examining animals in a clinic, animal shelter, or on a livestock operation, the opportunity exists to educate animal owners about the risk of disease spread, and take actions that prevent serving as a fomite or contributing to an environment that allows for disease spread. There are numerous resources to assist in this task as reviewed in this module.

Clients turn to accredited veterinarians as part of their animals', herds' or flocks' health management team. Implementing biosecurity and infection control measures to limit disease transmission, either between animals, from animals to humans, or from humans to animals, is an important responsibility of veterinarians. Accredited veterinarians' expertise in microbiology, virology, parasitology, epidemiology, public health, and knowledge of disease control prevention practices aimed at personal protection, cleaning and disinfection, and biosecurity principles makes them the best professional for clients to rely on for information.

Acknowledgments

This module was made possible, in part, by a Cooperative Agreement from the USDA-APHIS for the National Veterinary Accreditation Program. It was prepared by the Center for Food Security and Public Health, College of Veterinary Medicine at Iowa State University. Authors and contributors include:

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Photo and Illustration Credits

Page 1 The top photo depicts two small animal kennels that will be loaded onto an airplane. The kennels each have copies of the animal's Certificates of Veterinary Inspection on top. The bottom photo depicts Holstein heifers surrounding a water tank; biosecurity can help prevent or minimize their exposure to diseases. *Photo source: Danelle Bickett-Weddle, Iowa State University (both)*

Page 2 ***(Top)*** The top photo depicts three kittens in a cage at a shelter. Feline panleukopenia virus could be transmitted via aerosol, direct contact, fomites to these animals unless proper precautions were put in place. The bottom photo is a close up of air outlets on a livestock barn to keep appropriate air flow inside for the animals. *Photo sources: Dani Ausen, Iowa State University (top); Alex Ramirez, Iowa State University (bottom)*

(Bottom) The top photo depicts puppies in a whelping box. Should one of them contract parvovirus, it could quickly spread via direct contact and fomites to their litter mates. The bottom photo is a flock of sheep in a pen in a barn. Sheep can be carriers of Q fever and spread it via direct contact, aerosol, fomite, oral and vector (ticks) to other animals and humans. *Photo sources: Terry Engelken, Iowa State Univeristy (top); Danelle Bickett-Weddle, Iowa State University (bottom)*

Page 3 ***(Top)*** This photo contains syringes and needles, which have the potential to be fomites if not properly handled. Other blood collection items are included in the tote. *Photo source: Danelle Bickett-Weddle, Iowa State University*

(Bottom) The top photo depicts a dog eating canned food from a bowl. The bottom photo depicts a pig eating at an outdoor feeder. In either case, should the food or bowl/feeder become contaminated, this could result in oral ingestion of a disease agent. *Photo sources: Danelle Bickett-Weddle, Iowa State University (top); and Alex Ramirez, Iowa State University (bottom)*

Page 4 The top photo depicts the flea that transmits plague, *Xenopsylla cheopis*. The bottom photo depicts one of the mosquitoes that transmits West Nile virus, *Aedes aegypti*. *Photo source: Centers for Disease Control and Prevention Public Health Image Library (both)*

Page 5 This is the cover page of the 2010 version of the Compendium of Veterinary Standard Precautions. *Photo source: National Association of State Public Health Veterinarians*

Page 6 ***(Top)*** The top photo depicts a veterinarian properly washing their hands with soap and running water. *Photo source: Andrew Kingsbury, Iowa State University*

(Bottom) Needlesticks are one of the most common occupational injuries in veterinary practice. It is important to dispose of needles correctly after use as shown here. *Photo source: Dani Ausen, Iowa State University*

Page 7 ***(Top)*** Using a rabies pole to properly restrain an animal can help to limit disease exposure. *Photo source: Danelle Bickett-Weddle, Iowa State University*

(Center) This photo depicts three bottles of disinfectants or cleaning agents that can be hooked to a hose and dispensed. The one on the left is quaternary ammonium, the middle is bleach, and the one on the right is a detergent for cleaning. *Photo source: Dani Ausen, Iowa State University*

(Bottom) This graphic depicts necessary equipment for the first two steps of the four step effective cleaning process: dry cleaning and washing. *Graphic illustration by: Clint May, Iowa State University*

Page 9 ***(Top)*** This graphic depicts an example EPA Registration Number that can be found on EPA approved products. *Graphic illustration by: Clint May, Iowa State University*

(Bottom) This graphic illustrates the text on a disinfectant label that lists the organisms it has efficacy against. *Graphic illustration by: Clint May, Iowa State University*

Page 10 ***(Top)*** This photo depicts a wood stall that has bedding and other organic material in it. Those items must first be removed completely before washing and disinfecting. The wood planks are treated, making them easier to clean, but they are still more porous than metal, so attention to detail when cleaning is very important so as to remove all disease causing organisms. *Photo source: Danelle Bickett-Weddle, Iowa State University*

(Bottom) This photo illustrates a common practice in exam rooms. The disinfectant is sprayed onto the exam table and quickly followed by wiping to remove the debris left behind by the patient. While this serves to "clean" the table, contact time is almost non-existant, which means disinfection did not occur. *Photo source: Danelle Bickett-Weddle, Iowa State University*

Page 11 Wearing gloves, lye should always be poured into water as shown here, NEVER the other way around. *Graphic illustration by: Bridget Herrick, Iowa State University*

Page 13 ***(Top)*** Discharging quaternary ammonium compounds into waterways or watersheds can be toxic to fish. *Graphic illustration by: Bridget Herrick, Iowa State University*

(Bottom) This photo depicts a three-ring binder with Material Safety Data Sheets (MSDS) in them as well as three printouts for various chemical disinfectants laying beside it. *Photo source: Danelle Bickett-Weddle, Iowa State University*

Page 14 ***(Top)*** This photo depicts a veterinarian wearing protective outerwear, gloves and a face shield while measuring out the appropriate amount of disinfectant. Proper protection should always be considered when working with disinfectant solutions. *Photo source: Andrew Kingsbury, Iowa State University*

(Bottom) This is a photograph of a mixed animal veterinary clinic. Infectious disease protocols are necessary in veterinary clinics due to the various species and volume of animals examined on any given day. *Photo source: Alex Ramirez, Iowa State University*

Page 15 The top photo shows two signs: "Keep pets on leash" and "Keep small pets in a carrier." The bottom photo shows a waiting room with easy to clean surfaces. *Photo source: Bryan Buss, Iowa State University (both)*

Page 16 ***(Top)*** This photo depicts a large animal examining and treatment area. There is a yellow hydraulic squeeze chute in the background on the left. There are stainless steel panels around a circular holding pen leading up to a chute with a green head gate. The flooring is concrete with drains in the floor. These materials are easy to clean and disinfect and help minimize disease spread when used properly. *Photo source: Carla Huston, Mississippi State University*

(Bottom) The top photo shows various exam room instruments that can serve as fomites if not properly cleaned and disinfected between patients. Things such as a hemostat, rongeurs, oto scope, stethescope, and thermometer are displayed on the counter. The bottom photo shows an exam room with easy to clean counter tops and exam table, a sink, and various exam room items. *Photo source: Bryan Buss, Iowa State University (both)*

Page 17 ***(Top)*** This photo depicts the proper use of signage if a separate airspace is not available for an isolation ward. The cage tag alerts personnel that the animal is potentially contagious and must be handled appropriately. *Photo source: Andrew Kingsbury, Iowa State University*

(Bottom) The top photo shows inpatient facilities with two rows of stainless steel kennels used to house cats. The bottom photo shows an animal health technician obtaining hand sanitizer as a means to disinfect her hands after washing them. *Photo sources: Bryan Buss, Iowa State University (top); Dani Ausen, Iowa State University (bottom)*

Page 18 Three photos of methods of vector control: plastic spikes on rafters in a barn to deter birds from landing (top left), a rodent bait box located on the perimeter of an animal housing facility (top right), and a truck dispensing fly spray outside of a livestock barn (bottom). *Photo source: Danelle Bickett-Weddle, Iowa State University (both)*

Page 19 This photo depicts a man using a garden sprayer with disinfectant in it to spray his wheel wells, tires and rims of his truck after washing off the organic matter prior to leaving the beef feedlot. This serves to decrease the pathogen load carried on the vehicle to the next premises. *Photo source: Carla Huston, Mississippi State University*

Page 20 ***(Top)*** This photo depicts a 5-door veterinary vehicle with the side door and hatch open. The back seat is designated as the clean area and the back end is designated as the dirty area. Maintaining the internal cleanliness of a veterinary vehicle can help minimize the cross contamination of clothing and equipment. *Photo source: Andrew Kingsbury, Iowa State University*

(Center) This photo depicts the backseat "dirty" area of a pick-up truck. The container on the back seat is labeled dirty and holds used coveralls and scrub tops. The container on the floor holds boots and a solution of disinfectant to allow ample contact time between farm visits. *Photo source: Danelle Bickett-Weddle, Iowa State University*

(Bottom) This photo depicts a castrator and dehorner soaking in weak iodine and water in a metal bucket to remove the blood and organic debris. This is a necessary step to facilitate complete organic matter removal before disinfecting. *Photo source: Danelle Bickett-Weddle, Iowa State University*

Page 21 ***(Top)*** This photo shows a disassembled multiple dose syringe that has been rinsed multiple times with hot and allowed to air dry. *Photo source: Danelle Bickett-Weddle, Iowa State University (both)*

(Bottom) This illustration depicts a large farm with youngstock, older animals, and sick animals in an isolation facility. The numbers depict the order in which the animals should be visited or worked with so as to minimize disease agent transmission between them. *Graphic illustration by: Andrew Kingsbury and Dani Ausen, Iowa State University*

Knowledge Review Answers

Knowledge Review #1

Each prevention practice below is designed to limit exposure through one or more routes. Match each prevention practice to its route(s). More than one route can be prevented by each practice.

A.	Preventing rodents from accessing feed storage areas	**1.**	Aerosol
B.	Isolating sick animals to an area with its own ventilation	**2.**	Direct Contact
C.	Cleaning and sanitizing esophageal tubes between uses	**3.**	Fomite
D.	Increasing the distance between infected and susceptible species	**4.**	Oral
E.	Using needles only once	**5.**	Vector-borne
F.	Spraying the area with an approved insecticide		

The correct matches are A – 3, 4; B – 1, 2; C – 3, 4; D – 1, 2, 4, 5; E - 2, 3; F – 5.

Knowledge Review #2

A new client has just brought in her 4 year old spayed female dog that is lethargic, anorexic, febrile, mildly dehydrated, and polyuric but up-to-date on all vaccinations. You want to collect blood for a CBC and chemistry panel. Without a diagnosis, what is the minimum amount of PPE that should be worn in order to protect yourself and any staff members handling the dog? Select ALL that apply.

- **A.** Lab coat or smock
- **B.** Gloves
- **C.** Disposable shoe covers
- **D.** Surgical mask
- **E.** Safety glasses

The correct answers are A and B. A clean lab coat or smock will keep your clothing clean and will, once removed, help prevent transfer of any potentially infectious organisms to your next patient. Given the dog was febrile, gloves are warranted to protect you from any potential zoonotic disease agent(s).

Knowledge Review #3

What percentage of microorganisms can cleaning alone remove? Select ONE answer.

- **A.** 70%
- **B.** 80%
- **C.** 90%
- **D.** 100%
- **E.** Cleaning alone does not remove microorganisms, you need disinfection to remove microorganisms.

The correct answer is C. When done appropriately, cleaning alone can remove over 90% of microorganisms. This step also helps improve the disinfection process, since organic material can reduce a disinfectant's effectiveness.

Knowledge Review #4

For daily use, when the specific microorganism could differ depending on the patient, a broad spectrum disinfectant is often selected. Which of the following classes of disinfectants are considered broad spectrum?

A. Acids
B. Alcohols
C. Aldehydes
D. Alkalis
E. Biquanides
F. Halogens
G. Oxidizing agents
H. Phenols
I. Quaternary ammounium compounds

The correct answers are F, G, and H. The remaining disinfectants have a more narrow use against fewer organisms.

Knowledge Review #5

What factors should be taken into consideration when selecting an effective disinfectant? Select ALL that apply.

A. Smell
B. Safety
C. Availability
D. Label claims
E. Color
F. Cost
G. Environmental impact
H. Weather (temperature, humidity)
I. Surface texture

The correct answers are B, C, D, F, G, H, and I. Smell and color have no impact on the efficacy of a disinfectant.

Knowledge Review #6

Once a parvovirus positive puppy is admitted to your clinic, what biosecurity protocols should be implemented to decrease the risk of spread? Select ALL that apply.

A. Close off the exam room until it can be properly cleaned and disinfected
B. Disinfect all contaminated areas with either a hypochlorite (halogen) or oxidizing agent
C. Isolate the dog in an area with completely separate ventilation to prevent aerosol spread
D. Provide barrier protection (gowns, gloves, disposable booties) and a dedicated trash receptacle near the puppy
E. Remind staff to only use alcohol based hand sanitizers after handling the puppy

The correct answers are A, B, and D. C is incorrect because parvovirus is not spread to other animals via aerosol, only oral and fomite. The dog should be isolated away from other susceptible patients. E is incorrect because alcohol based sanitizers are not very effective against non-enveloped viruses.

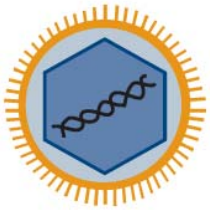
Knowledge Review #7

While examining a first calf beef heifer with a high fever, nasal discharge, and open mouth breathing, you want to look for oral lesions since she has a fetid breath odor. You properly restrain her and examine her mouth with a speculum. Despite no lesions, saliva and nasal discharge cover your skin and coveralls. What is the minimum "clean up" that should occur before leaving the farm? Select ALL that apply.

A. Wash the oral speculum in soap and water and return to its storage compartment in your vehicle.
B. Wash your hands, arms, neck and face with soap and water to remove the contamination.
C. Remove contaminated outer-clothing and store in the dirty part of your vehicle.
D. Clean and disinfect your boots

The correct answers are A, B, C, and D. At a minimum, remove the gross contamination from the speculum, your skin, and your boots. Removing your contaminated outer clothing is important before getting into the driver's seat (clean area). If unable to disinfect the speculum in the field, do so before using on another animal to prevent fomite/oral spread.

Selected* Viral Families, Viruses and Species Affected

	E: Enveloped NE: Nonenveloped	Virus Family (relative size) SS = single stranded DS = double stranded	Foreign Animal Disease (for US)	Zoonotic (Z)	Virus (Disease)	Humans Affected	Animal Species Affected
DNA Virus Families							
DNA	NE	Adenoviridae  80 – 100 nm DS linear			Bovine adenoviruses A, B, C		B
					Canine adenovirus (infectious canine hepatitis)		C
					Caprine adenovirus		Cp
					Equine adenoviruses A, B		Eq
					Fowl adenoviruses A – E		A
					Human adenoviruses A – F (respiratory and/or ocular disease)	H	NHP
					Ovine adenoviruses A, B, C		O
					Porcine adenoviruses A, B, C		P
DNA	E	Asfarviridae  175 – 215 nm DS linear	Φ		African swine fever		P
DNA	NE	Circoviridae  17 – 22 nm SS circular			Chicken anemia virus		A
					Porcine circovirus		P
					Psittacine beak and feather disease virus		A
DNA	E	Hepadnaviridae  42 nm partial DS circular		Z	Hepatitis B virus	H	NHP
DNA	E	Herpesviridae  150 - 200 nm DS linear	Φ		Alcelaphine herpesvirus-1 (malignant catarrhal fever)		B, Cv
					Avian herpesvirus 1 (infectious laryngotracheitis)		A
					Bovine herpesvirus 1 (infectious bovine rhinotracheitis)		B
					Bovine herpesvirus 2 (pseudo-lumpy skin disease, bovine mammillitis)		B
					Bovine herpesvirus 3/ bovine cytomegalovirus		B
					Canine herpesvirus 1, 2 (hemorrhagic disease of pups)		C
					Caprine herpesviruses 1, 2		Cp
					Equine herpesvirus 1 (equine viral rhinopneumonitis; equine abortion)		Eq
					Equine herpesvirus 2		Eq
					Equine herpesvirus 3 (equine coital exanthema)		Eq
					Equine herpesvirus 4 (equine viral rhinopneumonitis)		Eq
					Feline viral rhinotracheitis virus		F
					Human herpes simplex virus 1	H	NHP
					Human herpes simplex virus 2	H	
					Human herpesvirus 3/ varicella-zoster virus (chicken pox, shingles)	H	
					Human herpesvirus 4/ Epstein Barr virus	H	
					Human herpesvirus 5/ human cytomegalovirus	H	
					Human herpesviruses 6, 7 (roseola infantum)	H	

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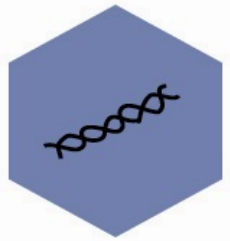
		Herpesviridae (continued)			Ictalurid herpesvirus 1 (channel catfish virus disease)		Fish
					Koi herpesvirus disease		Fish
					Marek's disease virus		A
			Φ		Oncorhynchus masou virus disease (or salmonid herpesvirus type 2 disease)		Fish
					Ovine herpesvirus-1		O
					Ovine herpesvirus-2 (malignant catarrhal fever)		B, Cp, Cv, O, P
					Porcine herpesvirus 2/ porcine cytomegalovirus		P
					Pseudorabies virus (Aujeszky's disease)		B, C, Cp, F, O, P
DNA	NE	Iridoviridae  125 – 300 nm DS linear	Φ		Epizootic haemotopoietic necrosis (EHN)		Fish
					Largemouth bass disease		Fish
DNA	NE	Papovaviridae  45 - 55 nm DS circular			Bovine papillomavirus		B
					Equine papillomavirus		Eq
					Human papillomavirus	H	
DNA	NE	Parvoviridae  18 - 26 nm SS linear			Adeno-associated viruses 1-6	H	
					B19 virus	H	
					Canine minute virus/ canine parvovirus 1		C
					Canine parvovirus 2 ("parvo")		C
					Feline panleukopenia virus (Feline parvovirus)		F
					Porcine parvovirus		P
DNA	E	Poxviridae  250 X 200 X 200 nm DS linear		Z	Bovine papular stomatitis virus	H	B
				Z	Contagious ecthyma/contagious pustular dermatitis/orf virus	H	C, Cp, Cv
			Φ	Z	Cowpox virus	H	B, F, R
					Feline pox virus		F
					Fowlpox virus		A
			Φ		Lumpy skin disease virus		B, Bf
			Φ	Z	Monkeypox virus	H	NHP, R
				Z	Pseudocowpox virus (milker's nodules)	H	B
			Φ		Sheep and goat pox viruses		Cp, O
					Smallpox virus (Variola)	H	
					Swinepox virus		P
				Z	Vaccinia virus	H	B, L, P

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RNA Virus Families							
RNA	E	Arenaviridae  110 - 300 nm SS linear segments	Φ	Z	Lassa virus	H	NHP, R
				Z	Lymphocytic choriomeningitis virus	H	C, NHP, P, R
			Φ	Z	Machupo virus (Bolivian hemorrhagic fever)	H	NHP, R
RNA	E	Arteriviridae  50 – 70 nm SS linear			Equine arteritis virus (equine viral arteritis)		Eq
					Lactate dehydrogenase elevating virus		R
					Porcine respiratory and reproductive syndrome virus		P
					Simian hemorrhagic fever virus		NHP
RNA	NE	Astroviridae  28 – 30 nm SS linear			Avian nephritis viruses 1, 2		A
					Bovine astrovirus		B
					Feline astrovirus (gastroenteritis)		F
					Human astroviruses 1-8 (gastroenteritis)	H	
					Ovine astrovirus (gastroenteritis)		O
					Porcine astrovirus (porcine acute gastroenteritis)		P
					Turkey astrovirus (poultry enteritis and mortality syndrome)		A
RNA	NE	Birnaviridae  60 nm DS linear segments			Infectious bursal disease virus		A
					Infectious pancreatic necrosis (IPN) (hemorrhagic kidney syndrome)		Fish
RNA	E	Bunyaviridae  80 – 120 nm SS linear segments	Φ		Akabane virus (Akabane/congenital arthrogryposis-hydranencephaly)		B, Cp, O
					Cache Valley virus	H	B, O
				Z	California encephalitis virus	H	R
			Φ	Z	Crimean-Congo hemorrhagic fever virus	H	A, B, C, L, O
			Φ*	Z	Hantaviruses (various serotypes)*	H	R
				Z	Jamestown Canyon virus	H	Cv
				Z	La Crosse virus (La Crosse encephalitis)	H	Cp, Cv, R
			Φ	Z	Nairobi sheep disease virus	H	Cp, O, R
			Φ	Z	Rift Valley fever virus	H	B, C, Cp, F, O
RNA	NE	Caliciviridae  30 -38 nm SS linear			Bovine enteric calicivirus		B
					Canine calicivirus		B
					Feline caliciviruses (upper respiratory disease)		F
					Fowl calicivirus		A
				Z	Hepatitis E virus	H	P
					Noroviruses (Norwalk and Norwalk-like viruses)	H	
					Porcine enteric calicivirus		P
			Φ		Rabbit hemorrhagic disease virus		L
					San Miguel sea lion virus		Other, P
			Φ	Z	Vesicular exanthema of swine virus (vesicular exanthema)	H	B, Eq, NHP, P

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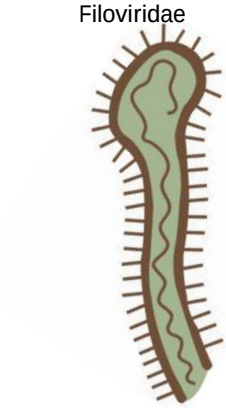
RNA	E	Coronaviridae  80 – 160 nm SS linear			Avian infectious bronchitis virus		A
					Bovine coronavirus		B
					Canine coronavirus		C
					Feline enteric coronaviruses		F
					Feline infectious peritonitis virus		F
					Human coronaviruses (colds)	H	
			Φ		Porcine epidemic diarrhea virus		P
					Porcine hemagglutinating encephalomyelitis virus		P
			Φ	Z	Severe acute respiratory syndrome (SARS) virus	H	F
					Transmissible gastroenteritis (TGE) virus		P
					Turkey coronavirus (bluecomb disease)		A
RNA	E	Filoviridae  790 – 970 X 80 nm SS linear	Φ	Z	Ebola virus	H	NHP
			Φ	Z	Marburg virus	H	NHP
RNA	E	Flaviviridae  45 – 60 nm SS linear			Border disease virus		O
					Bovine viral diarrhea (BVD) viruses 1, 2		B
			Φ		Classical swine fever virus (hog cholera)		P
			Φ	Z	Dengue virus	H	NHP
					Hepatitis C virus	H	
			Φ	Z	Japanese encephalitis virus	H	A, P
			Φ	Z	Louping ill virus	H	A,B, C, Cp, Cv, Eq, O, P,R
			Φ	Z	Murray valley encephalitis virus	H	A, B, C, Eq
			Φ	Z	Omsk hemorrhagic fever virus	H	R
				Z	St. Louis encephalitis virus	H	A, Eq
			Φ	Z	Tick-borne encephalitis viruses (various subtypes)	H	B, C, Cp, O, R
			Φ	Z	Yellow fever virus	H	NHP
			Φ	Z	Wesselsbron virus	H	B, Cp, O
				Z	West Nile Virus (WNV) (West Nile fever)	H	A, Eq
RNA	NE	Nodaviridae  30 nm SS linear			Viral encephalopathy and retinopathy (viral nervous necrosis)		Fish

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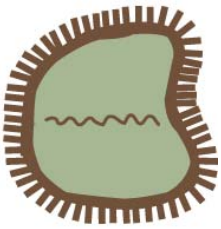
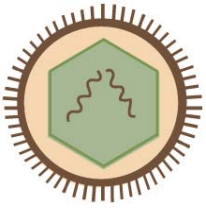
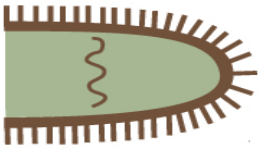
RNA	E	Orthomyxoviridae  80 - 120 nm SS linear segments			Infectious salmon anemia		Fish
				Z	Influenza virus A:	H	A, Eq, F, Fr, P
				Z	Avian influenza	H	A, Eq, P
					Equine influenza		Eq
				Z	Swine influenza	H	A, P
					Human influenza	H	Fr, P
				Z	Influenza virus B: (human influenza)	H	Fr
					Influenza virus C: (human influenza)	H	P
RNA	E	Paramyxoviridae  150 – 300 nm SS linear	Φ	Z	Avian paramyxovirus type 1 (Newcastle disease)	H	A
					Avian paramyxoviruses 2-9		A
					Bovine respiratory syncytial virus (BRSV)		B, O
					Canine distemper virus		C, Fr
					Canine parainfluenza virus		C
			Φ	Z	Hendra virus	H	Bt, Eq, F
					Human parainfluenza viruses 1-4	H	
					Measles virus	H	NHP
					Mumps virus	H	
			Φ	Z	Nipah virus	H	Bt, C, Cp, Eq, F, O, P
					Parainfluenza 3 virus	H	B, O
			Φ		Peste de petitis ruminants virus		Cp, O
					Respiratory syncytial virus	H	
			Φ		Rinderpest virus		B, Cp, O, P
RNA	NE	Picornaviridae  28 - 30 nm SS linear			Avian enteroviruses (encephalomyelitis, hepatitis)		A
					Bovine enteroviruses		B
					Bovine rhinoviruses		B
				Z	Encephalomyelocarditis virus (encephalomyelocarditis)	H	NHP, P, R
					Equine rhinoviruses 1, 2		Eq
			Φ		Foot and mouth disease virus[¥]	H[¥]	B, Ca, Cp, Cv, O, P
				Z	Human hepatitis A virus	H	NHP
					Human rhinoviruses	H	
					Poliovirus	H	
			Φ		Porcine enteroviruses (porcine enteroviral encephalomyelitis/ Teschen-Talfan disease)		P
			Φ	Z	Swine vesicular disease virus	H	P
RNA	NE	Reoviridae  60 - 80 nm DS linear segments	Φ		African horse sickness viruses 1-10		Eq
					Avian orthoreoviruses		A
					Bluetongue viruses 1-24		B, Cp, Cv, O
				Z	Colorado tick fever virus	H	R
					Epizootic hemorrhagic disease viruses		B, Cv, O
					Rotaviruses, group A to F (rotaviral gastroenteritis)	H	B, Eq, L, O, P, R

A=avian; B=bovine; Bt=bat; C=canine; Cp=caprine; Cv=cervine; Eq=equine; F=feline; Fr=ferret; H=human; L=lagomorph; R=rodent; NHP=non-human primate; O=ovine; P=porcine; **Diseases in RED or with a Φ = Foreign Animal Diseases**

Selected* Viral Families, Viruses and Species Affected

	E: Enveloped NE: Nonenveloped	Virus Family (relative size) SS = single stranded DS = double stranded	Foreign Animal Disease (for US)	Zoonotic (Z)	Virus (Disease)	Humans Affected	Animal Species Affected
RNA	E	Retroviridae  80 – 130 nm 2 copies SS linear			Avian leukosis virus		A
					Bovine immunodeficiency virus		B
					Bovine leukemia virus (BLV)		B
					Caprine arthritis-encephalitis virus		Cp, O
					Equine infectious anemia virus (EIA)		Eq
					Feline immunodeficiency virus (FIV)		F
					Feline leukemia virus (FeLV)		F
					Human immunodeficiency viruses (HIV-1, HIV-2) (acquired immunodeficiency syndrome - AIDS)	H	
					Human T-lymphotropic viruses 1, 2	H	
					Maedi-visna virus (ovine progressive pneumonia)		Cp, O
					Ovine pulmonary adenocarcinoma virus (pulmonary adenomatosis)		Cp, O
					Simian immunodeficiency virus		NHP
					Simian leukemia viruses 1-3		NHP
RNA	E	Rhabdoviridae  180 X 75 nm SS linear	Φ		Bovine ephemeral fever virus		B
					Infectious hematopoietic necrosis (IHN)		Fish
				Z	Rabies	H	All mammals
					Spring viremia of carp		Fish
				Z	Vesicular stomatitis virus (Indiana 1 and New Jersey subtypes)	H	B, Cp, Eq, O, P
			Φ	Z	Vesicular stomatitis virus (Indiana 2 and 3 subtypes)	H	B, Cp, Eq, O, P
					Viral hemorrhagic septicemia (Egtved disease)		Fish
RNA	E	Togaviridae  70 nm SS linear		Z	Eastern equine encephalitis virus (EEE)	H	A, Bt, Eq, P, R
					Rubella virus	H	
				Z	Venezuelan equine encephalitis virus (VEE)	H	A, Eq, R
					Spring viremia of carp		Fish
				Z	Western equine encephalitis virus (WEE)	H	A, Eq

¥ Unconfirmed mild human cases have been reported.

Chart researched and compiled by Kristine Edwards, MA, DVM, MPH; Anna Rovid-Spickler, DVM, PhD and Glenda Dvorak, DVM, MS, MPH.

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Virus family graphics adapted with permission from Medical Microbiology, 4th edition, Baron S., editor. 1996. Available at http://gsbs.utmb.edu/microbook/images/fig41_6.jpg

*This table was developed as a supplement for the CFSPH "Disinfection 101" document (http://www.cfsph.iastate.edu/BRM/disinfectants.htm) which provides an overview of important principles for the development of disinfection protocols, including how to choose an appropriate disinfectant. We expect this virus table to be useful for veterinarians, veterinary students and graduate students in virology. The mammalian, avian and fish viruses selected are those we perceive to be the ones veterinarians will most likely need to know about.

Bacterial Group Review Table

Gram Positive Cocci	Gram Negative Aerobic	Anaerobic
Enterococcus *Micrococcus* *Staphylococcus* *Streptococcus*	*Actinobacillus* *Aeromonas* *Bartonella* *Bordetella* *Brucella* *Burkholderia* *Capnocytophaga* *Citrobacter* *Enterobacter* *Enterobacteriaceae* *Escherichia* *Francisella* *Haemophilus* *Klebsiella* *Legionella* *Moraxella* *Neisseria* *Pasteurella* *Pseudomonas* *Salmonella* *Serratia* *Shigella* *Vibrio* *Yersinia*	*Actinomyces—GP* *Bacteroides—GN* *Clostridium—GP* *Fusobacterium—GN* *Lactobacillus—GP* *GP = Gram-positive* *GN = Gram negative*
Gram Positive Rods	**Gram Negative Rods, Curved-Spiral Shaped**	**Mycoplasmas and Obligate Intracellular**
Actinomycetes *Bacillus* *Coryneform* *Erysipelothrix* *Listeria* *Mycobacterium* *Nocardia* *Rhodococcus* *Streptomyces*	*Borrelia* *Campylobacter* *Helicobacter* *Leptonema* *Leptospira* *Treponema*	*Chlamydia* *Coxiella* *Ehrlichia* *Mycoplasma* *Rickettsia* *Ureaplasma*

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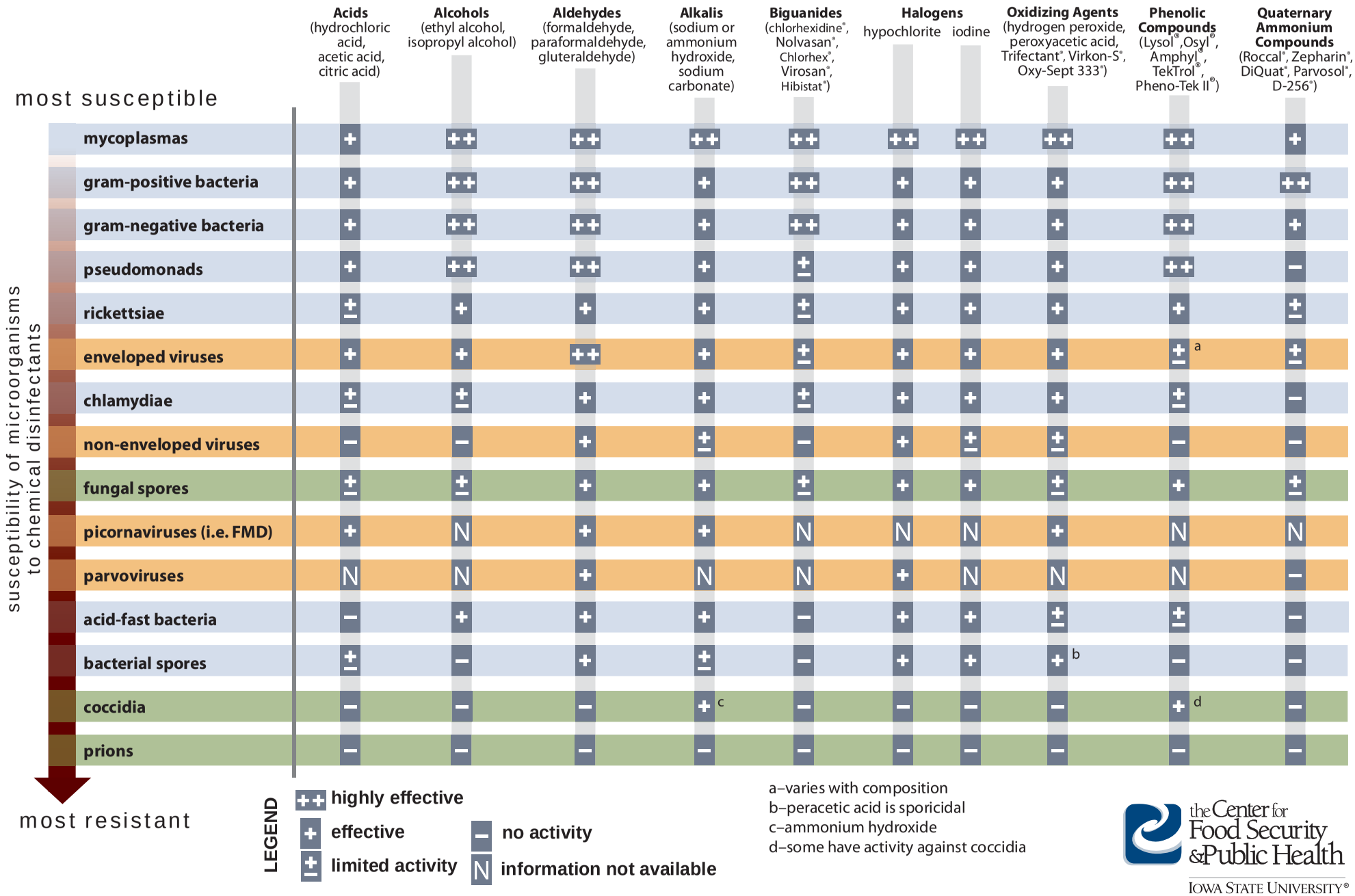
The Antimicrobial Spectrum of Disinfectants

Chemical Disinfectants

Note: Removal of organic material must always precede the use of any disinfectant.



LEGEND

- ++ highly effective
- + effective
- ± limited activity
- – no activity
- N information not available

a–varies with composition
b–peracetic acid is sporicidal
c–ammonium hydroxide
d–some have activity against coccidia

Adapted from: Linton AH, Hugo WB, Russel AD. Disinfection in Veterinary and Farm Practice. 1987. Blackwell Scientific Publications; Oxford, England; Quinn PJ, Markey BK. Disinfection and Disease Prevention in Veterinary Medicine, In: Block SS, ed., Disinfection, Sterilization and Preservation. 5th edition. 2001. Lippincott, Williams and Wilkins: Philadelphia.

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DISINFECTANT PRODUCT LABELS

Understanding the information on a disinfectant product label is essential for effective disease organism removal and the safety of those handling the product. Always read the product label before use. It is a violation of federal law to use a product in a manner inconsistent with its labeling. In order to increase awareness of what a product label contains, this handout will provide you with a step-by-step guide of a disinfectant label.

Only products with EPA registration numbers should be used. This number indicates the product has been reviewed by the EPA and poses minimal risk to animals, people and the environment when used in accordance with their label.

This section will describe the hazards related to humans and animals when using this product. It recommends personal protective gear that should be worn, what effects it will have on the environment and treatment information should it be splashed into the eyes or ingested.

EPA Reg. No. 1658 – XX

COMPANY Y

EPA Est. No. 16XX – MO – 1

PRODUCT X

Disinfect-Cleaner-Sanitizer-Fungicide-Mildewstat-Virucide*–Deodorizer for Hospitals, Institutional and Industrial Use

Effective in hard water up to 400 ppm hardness (calculated as CaCO3) in the presence of 5% serum contamination

ACTIVE INGREDIENTS:
Octyl decyl dimethyl ammonium chloride.....1.650%
Dioctyl dimethyl ammonium chloride.....0.825%
Didecyl dimethyl ammonium chloride.....0.825%
Alkyl (C14, 50%, C12, 40%; C16, 10%)
Dimethyl benzyl ammonium chloride.....2.200%
INERT INGREDIENTS:.....94.500%
TOTAL:.....100.000%

KEEP OUT OF REACH OF CHILDREN

DANGER

HAZARD TO HUMANS AND DOMESTIC ANIMALS

PRECAUTIONARY STATEMENTS

CORROSIVE: Causes severe eye and skin damage. Do not get into eyes, on skin or clothing. Wear goggles or face shield and rubber gloves when handling Product X. Harmful or fatal if swallowed. Wash thoroughly with soap and water after handling.
ENVIRONMENTAL HAZARDS: This product is toxic to fish. Do not discharge effluent containing this product into lakes, streams, ponds, estuaries, oceans or other waters unless in accordance with the requirements of a National Pollutant Discharge Elimination System (NPDES) permit and the permitting authority has been notified in writing prior to discharge. For guidance contact your State Water Board or Regional Office of the EPA.
PHYSICAL AND CHEMICAL HAZARDS: Do not use or store near heat or open flame.
STATEMENT OF PRACTICAL TREATMENT: In case of contact, immediately flush eyes or skin with plenty of water for at least 20 minutes. For eyes, call a physician. Remove and wash contaminated clothing before reuse. If ingested, call a physician immediately.
NOTE TO PHYSICIAN: Probable mucosal damage may contraindicate the use of gastric lavage.

Manufactured by
Company Y Chemical Company, Sometown, Somestate 12345

It is a violation of Federal Law to use this product in a manner inconsistent with its labeling.

DIRECTIONS FOR USE

Product X is a germicide, soapless cleaner and deodorant which is effective in water up to 400 ppm hardness in the presence of organic soil (5% serum). When used as directed, will not harm tile, terrazo, resilient flooring, concrete, painted or varnished wood, glass or metals.

FOR USE IN VETERINARY CLINICS, ANIMAL CARE FACILITIES, LIVESTOCK FACILITIES AND ANIMAL QUARANTINE AREAS

Apply Product X to walls, floors and other hard (inanimate) non-porous surfaces with a cloth, mop or mechanical spray device so as to thoroughly wet surfaces. Prepare a fresh solution daily or when use solution becomes visibly dirty.

Disinfection – To disinfect hard surfaces, use 1 fluid ounce of Product X per gallon of water. Apply by immersion, flushing solution over treated surfaces with a mop, sponge or cloth to thoroughly wet surfaces. Allow treated surfaces to remain moist for at least 15 minutes before wiping or rinsing. Product X will disinfect hard non-porous surfaces in veterinary clinics, animal care facilities, livestock facilities and animal quarantine areas. *For heavily soiled areas, a preliminary cleaning is required.*

2 oz. gallon use-level. The activity of Product X has been evaluated in the presence of 5% serum and 400 ppm hard water by the AOAC use dilution test and found to be effective against a broad spectrum of gram negative and gram positive organisms as represented by:

Pseudomonas aeruginosa	Pasteurella multocida
Enterobacter aerogenes	Enterococcus faecium
Staphylococcus aureus	Streptococcus faecalis
Salmonella choleraesuis	Shigella dysenteriae
Escherichia coli	Brevibacterium ammoniagenes
Streptococcus pyogenes	Salmonella typhi
Klebsiella pneumoniae	Serratia marcescens
Streptococcus agalactiae	Actinomyces pyogenes

Boot bath. Use 1.5 fluid ounces per gallon in boot baths. Change solution daily and anytime it becomes visibly soiled. Use a bristle brush to clean soil from boots before disinfecting with Product X.
Disinfecting trucks and farm vehicles: Clean and rinse vehicles and disinfect with 1 fluid ounce per gallon of Product X. If desired, rinse after 12 minutes contact or leave unrinsed. Do not use Product X on vaccination equipment, needles or diluent bottles as the residual germicide may render the vaccines ineffective.
Sanitizing-Non-Food Contact Surfaces (such as floors, walls, tables, etc.): At 1 oz. per 2% gallon use-level, Product X is an effective sanitizer against Staphylococcus aureus and Klebsiella pneumoniae on hard porous and non-porous environmental surfaces. Treated surfaces must remain wet for 30 seconds.

Some products may have multiple uses (i.e., cleaning versus disinfection) and require different dilutions and contact times for such actions.

This section describes what disease organism the product controls, as well as where, how and when to use it.

Specialty applications for the product (i.e., boot baths, vehicle disinfection) will also be listed.

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Characteristics of Selected Disinfectants

For More Information, see the 'Disinfection 101' document at www.cfsph.iastate.edu

Disinfectant Category	Alcohols	Aldehydes	Biguanides	Halogens: Hypochlorites	Halogens: Iodine Compounds	Oxidizing Agents	Phenols	Quaternary Ammonium Compounds (QAC)
Sample Trade Names	Ethyl alcohol Isopropyl alcohol	Formaldehyde Glutaraldehyde	Chlorhexidine Nolvasan® Virosan®	Bleach	Betadyne® Providone®	Hydrogen peroxide Peracetic acid Virkon S® Oxy-Sept 333®	One-Stroke Environ® Pheno-Tek II® Tek-Trol®	Roccal® DiQuat® D-256®
Mechanism of Action	•Precipitates proteins •Denatures lipids	•Denatures proteins •Alkylates nucleic acids	•Alters membrane permeability	•Denatures proteins	•Denatures proteins	•Denature proteins and lipids	• Denatures proteins • Alters cell wall permeability	• Denatures proteins • Binds phospholipids of cell membrane
Advantages	•Fast acting •Leaves no residue	•Broad spectrum	•Broad spectrum	•Broad spectrum •Short contact time •Inexpensive	•Stable in storage •Relatively safe	•Broad spectrum	• Good efficacy with organic material • Non-corrosive • Stable in storage	• Stable in storage • Non-irritating to skin • Effective at high temperatures and high pH (9-10)
Disadvantages	•Rapid evaporation •Flammable	•Carcinogenic •Mucous membranes and tissue irritation •Only use in well ventilated areas	•Only functions in limited pH range (5–7) •Toxic to fish (environmental concern)	•Inactivated by sunlight •Requires frequent application •Corrodes metals •Mucous membrane and tissue irritation	•Inactivated by QACs •Requires frequent application •Corrosive •Stains clothes and treated surfaces	•Damaging to some metals	• Can cause skin and eye irritation	
Precautions	Flammable	Carcinogenic		Never mix with acids; toxic chlorine gas will be released			May be toxic to animals, especially cats and pigs	
Vegetative Bacteria	Effective	Effective	Effective	Effective	Effective	Effective	Effective	YES—Gram Positive Limited—Gram Negative
Mycobacteria	Effective	Effective	Variable	Effective	Limited	Effective	Variable	Variable
Enveloped Viruses	Effective	Effective	Limited	Effective	Effective	Effective	Effective	Variable
Non-enveloped Viruses	Variable	Effective	Limited	Effective	Limited	Effective	Variable	Not Effective
Spores	Not Effective	Effective	Not Effective	Variable	Limited	Variable	Not Effective	Not Effective
Fungi	Effective	Effective	Limited	Effective	Effective	Variable	Variable	Variable
Efficacy with Organic Matter	Reduced	Reduced	?	Rapidly reduced	Rapidly reduced	Variable	Effective	Inactivated
Efficacy with Hard Water	?	Reduced	?	Effective	?	?	Effective	Inactivated
Efficacy with Soap/ Detergents	?	Reduced	Inactivated	Inactivated	Effective	?	Effective	Inactivated

? Information not found

Disclaimer: The use of trade names does not in any way signify endorsement of a particular product. For additional product names, please consult the most recent Compendium of Veterinary Products.

References: Linton AH, Hugo WB, Russel AD. Disinfection in Veterinary and Farm Practice. 1987. Blackwell Scientific Publications; Oxford, England; Quinn PJ, Markey BK. Disinfection and Disease Prevention in Veterinary Medicine, In: Block SS, ed., Disinfection, Sterilization and Preservation. 5th edition. 2001. Lippincott, Williams and Wilkins: Philadelphia.

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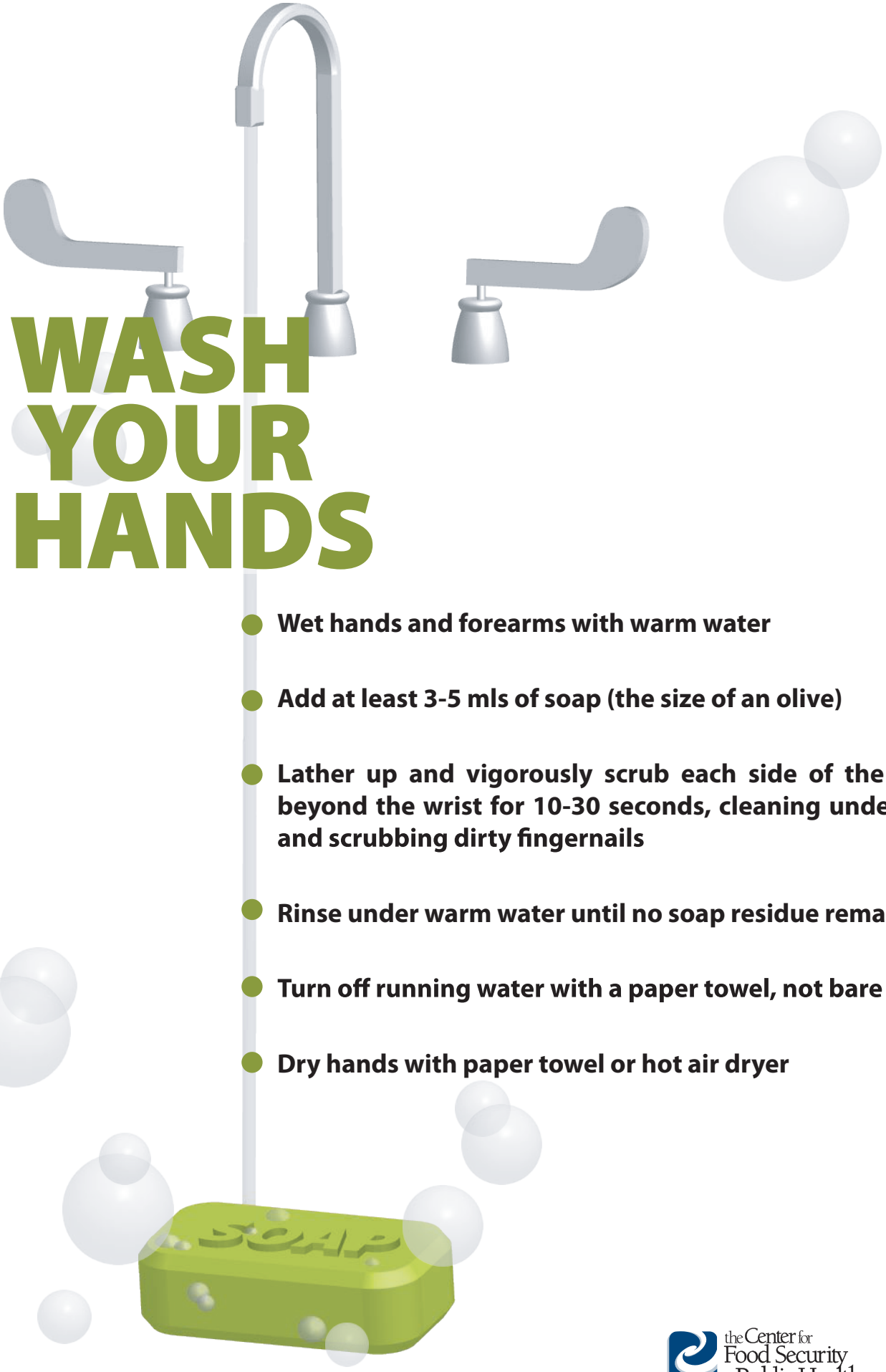

WASH YOUR HANDS

- Wet hands and forearms with warm water
- Add at least 3-5 mls of soap (the size of an olive)
- Lather up and vigorously scrub each side of the hands beyond the wrist for 10-30 seconds, cleaning under rings and scrubbing dirty fingernails
- Rinse under warm water until no soap residue remains
- Turn off running water with a paper towel, not bare hands
- Dry hands with paper towel or hot air dryer

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FLY CONTROL MEASURES

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Every farm has flies and while they are all considered a nuisance, certain types are responsible for spreading diseases. To decrease disease risk to your livestock, it is important to understand where flies live and breed and the various control methods available.

Life cycle

- Flies progress through 4 life stages: egg, larva (maggots), pupa, and adult. For some species, these stages can take less than 2 weeks to occur in warm weather.
- The adult is the stage capable of spreading disease as they contact the environment and animals, carrying disease organisms on their legs and mouthparts.
- Adult flies prefer to lay their eggs in wet organic matter, such as fresh manure and spilled feed.
  - Moisture is needed to prevent the fly eggs, larvae and pupae from drying out; controlling this moisture is an important step in the reduction of fly numbers on your farm.

Integrated pest management

- Integrated pest management is the best approach to controlling flies. This involves monitoring, environmental control and treatment of animals as a multiple attack on flies.
  - Resistance to pesticides has occurred over the years, so incorporating multiple management strategies has been the most successful control program.
  - There is no insecticide on the market that will make up for poor sanitation.

Monitoring

- Monitoring can be as sophisticated as counting fly specks on paper placed throughout a barn or as simple as observing animal housing areas and the environment for the presence of adult flies.
  - Either way, knowing the challenge level helps when planning to target them for removal.
- Areas to monitor include: calf housing, accumulated wet bedding in pens, manure around feeders, lagoons, feed storage areas (bins, troughs, bunkers, silos), wet areas in the environment and carcasses.
  - It is best to monitor these areas before fly season begins and every two weeks throughout fly season.

Environment

- The environment must be managed to decrease the areas where flies can lay their eggs.
- Manure must be disturbed once a week to prevent fly eggs from hatching. This can be done by dragging dry lots, pastures, scraping and hauling manure to storage or spreading it in thin layers on pastures.
  - Stored manure can be an egg laying area for flies if it does not have a hard crust on top. Agitating regularly or adding water will drown the fly larvae.
- Organic debris (e.g. spilled feed, bedding, rotten vegetation and leaf litter) should also be disturbed once a week to prevent fly eggs from hatching.
  - Cleaning up spilled feed, scraping around bunks and preventing accumulations of moist bedding will decrease the adult fly population.
- Fly parasites have been used with success on some farms.
  - Predatory mites and beetles eat fly larvae that live in manure, bedding and vegetation.
  - Small wasps lay one of their eggs on the pupal stage of a fly in manure; the wasp egg then develops into a larva which kills the fly pupa by feeding on it.
  - However, the manure cannot be excessively wet as this prevents parasite movement and larva/pupa destruction.
  - Some wasps feed by piercing through the outer protective layer of fly pupae and consume them, resulting in fly death.
  - Certain fly parasites can only be used in specific geographic areas because they may feed on other beneficial insects, so check with your local extension specialist for recommendations.
- Area sprays (knockdown) are fine mists of insecticide that rely on contact with the adult fly to kill it.
  - They should be used the same day they are mixed and applied in areas of high fly concentration because they do not last long in the environment (1-2 hours).
  - Due to evaporation, they should not be used at temperatures over 90°F and they are not effective at low temperatures (below 65°F).
  - If used in combination with predatory parasites, be sure to use products with a low toxicity to those species.
- Residual sprays are insecticides that can be applied to shaded surfaces where flies rest to kill them through contact.
  - Places such as barn walls, ceiling, rafters and calf hutches are commonly treated areas.
  - Reapply after a rain as it will wash off the insecticide.
  - To avoid insecticide resistance, it is a good idea to alternate between area and residual sprays.
  - These cannot be used in dairy milking parlors.
  - If used in combination with predatory parasites, be sure to use products with a low toxicity to those species.
- Baits and fly traps have efficacy against house flies and can be used as part of a pest management program, especially in areas where chemical sprays are prohibited (dairy milking parlors).
  - Baits should NOT be placed in areas where animals will have access to them or where they could fall and contaminate feed, water or milk.

Animals

- Dusters or dust bags that contain insecticide work well for pastured cattle if the animals are forced to pass by them to get to feed, water or mineral.
  - Monitor the dusters for use; cattle should use them every 2-3 days to be effective.
  - To ensure insecticide is applied to their face, they should be placed low enough so cattle have to drop their heads to go through them.
  - There should be 2 dust bags for every 50-60 animals to ensure every animal has access.
  - With the smaller stature of calves, dusters must be hung at a level that is appropriate.
- Back rubbers or oilers are similar to dusters; they rely on contact with the insecticide but use an oil solution (diesel fuel #2) instead of dust.
  - Monitor the back rubbers for use; cattle should use them every 2-3 days to be effective.
  - To ensure insecticide is applied to their face, they should be placed low enough so cattle have to drop their heads to go through them.
  - There should be 20 feet of contact space for every 50-60 cows to ensure every animal has access.
  - Add insecticide every 2-4 weeks to maintain effectiveness.
- Pour-ons or sprays are absorbed by the animal and act to repel flies that feed on blood (as well as lice and grubs).
  - They are directly applied to animals and have to be reapplied every 3 weeks in the case of horn flies.
  - Pour-ons are more labor intensive than some other options listed here, but effective.
- Impregnated ear tags can provide many weeks of protection against flies.
  - Due to resistance to pesticides, it is recommended to alternate between a pyrethroid ear tag and an organo phosphate or a pyrethroid/organophosphate mixture every year.
  - Two ear tags are recommended for face fly control.
  - Contact your local extension specialist for recommendations in your area.
- Feed with larvicide in it passes through the cow and the product kills the larvae in the manure so that adults cannot emerge.
  - They are very effective at killing developing flies but must be included in the feed ration at least 3 weeks prior to fly season.
  - For maximum efficacy, all animals on a farm and in a region must be treated or flies will deposit their eggs in untreated animal manure and adults will emerge.
- Boluses with insect growth regulators (IGR) have efficacy against flies and can be used early in the fly season to delay use of ear tags or use them late in the season to extend treatment.
  - These can affect non-target insects like the dung beetle and should only be used in high fly infestation areas.

It is a violation of state and federal law to use a pesticide in any manner that differs from the product label. Use only according to label directions to avoid meat or milk residue hazards, environmental damage, and animal or human injury.

Fly References:

- Patrick CD. Self-treatment Devices for Horn Fly, Face Fly, and Lice Control on Beef Cattle. Beef Cattle Handbook BCH-3800 published electronically and accessed November 11, 2005 at *http://www.iowabeefcenter.org/pdfs/bch/03800.pdf*
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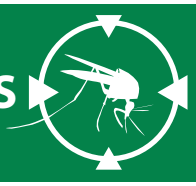
MOSQUITO CONTROL MEASURES



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Mosquitoes can spread diseases to animals and people. Control programs should focus on decreasing their numbers to minimize the risk of disease spread to you and your animals.

Control of Mosquito Egg Laying Sites

- This is the best way to control mosquitoes since they lay eggs in specific areas and these areas can be managed.
- Add drainage holes to structures and containers that may trap water (barrels, old tires).
- Change or circulate the water in stock tanks, pet bowls and birdbaths at least once a week.
- Drain tarps and covers of collected rainwater after a rain (i.e. silage covers).
- Pick up and properly dispose of all trash, especially anything that could hold water.
- Thin out weeds and remove old leaves from ponds. This will allow natural mosquito-eating fish to easily access areas where mosquitoes lay their eggs.
- Grade areas where road ruts, potholes and hoofprints exist (around stock tanks, ponds).
- Grade newly developed land to prevent standing water. These areas create areas for mosquitoes to lay eggs.
- Fill tree holes with sand, mortar or place drainage holes to prevent standing water.
- Clean roof gutters to prevent them from becoming clogged and holding water.

Control of Mosquito Larvae ("wigglers")

- Check with your local extension office or department of pest management to determine which pesticides are approved for use in your area.
- The use of pesticides should only be supplemental to controlling mosquitoes through the reduction and management of mosquito egg laying areas.
- Do not apply pesticides to moving water (i.e. streams).
- Products labeled only for home and garden mosquito larval control may be used. Follow all label directions.
- Non-chemical pesticides can be used.
  - **Always follow all label directions**
  - BTI (*Bacillus thuringiensis israelensis*) pronounced ba-SILL-us THUR-in-GEN-sus IZ-real-EN-sus.
  - BTI granules can be spread over an area of pasture that is flood-prone. Use at the beginning of the mosquito season and re-apply in the middle of the season.
  - BTI dunks can be used to treat stock tanks. One dunk can treat up to 100 square feet of water surface and can last up to 30 days.
  - Methoprene products can be used to treat areas that collect water. These include bird baths, urns, old tires, flower pots, abandoned swimming pools, etc.

Control of Mosquito Adults

- This is the least efficient way to control mosquitoes.
- Special equipment is needed to apply pesticides to kill adult mosquitoes (adulticides). Small droplets are produced that drift through the air and contact adult mosquitoes to kill them.
- Check with your local extension office or department of pest management to determine which pesticides are approved for use in your area.
- The use of pesticides should only be supplemental to controlling mosquitoes through the reduction and management of mosquito egg laying sites.
- Individuals may use hand-held Ultra Low Volume foggers, portable or fogging attachments for tractors or lawn mowers.
- Pyrethrin or 5% malathion can be fogged outdoors. Follow all label directions.
- Contact your local extension agent for assistance in developing a mosquito management plan.

Personal Protection

- Protect yourself against mosquitoes.
- When outside, wear long pants and long sleeves to cover skin.
- Use insect repellants on exposed skin. Repellants with DEET (N,N-diethyl-meta-toluamide) are the most effective.
- DEET is an insect repellant that is safe to use on people but not on pets.
- Make sure screens on windows and doors are in good repair.

It is a violation of state and federal law to use a pesticide in any manner that differs from the product label. Use only according to label directions to avoid meat or milk residue hazards, environmental damage, and animal or human injury.

Mosquito References:

- Lawler SP, Lanzaro GC. Managing Mosquitoes on the Farm. Department of Entomology, University of California, Davis. *http://axp.ipm.ucdavis.edu/PDF/MOSQ/mosquitoesonfarm.pdf*
- Potter MF, Townsend L, Knapp FW. Mosquitoes: Practical Advice for Homeowners. University of Kentucky Department of Entomology. *http://www.uky.edu/Agriculture/Entomology/entfacts/misc/ef005.htm*
- Stringham M, Watson W. Managing Waste Lagoons to Control Mosquito Breeding. North Carolina State University Department of Entomology. *http://www.ces.ncsu.edu/depts/ent/notes/MedVet/wnv-manage.htm*
- Larvicides for Mosquito Control. United States Environmental Protection Agency. *http://www.epa.gov/pesticides/health/mosquitoes/larvicides4mosquitoes.htm*

TICK CONTROL MEASURES

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There are approximately 850 different species of ticks in the world. About 100 species are capable of spreading disease or causing economic losses from decreased weight gain or secondary infections. To control them and prevent disease spread, it is important to understand their life cycle.

Life cycle

- Ticks progress through 4 life stages: egg, larva (6 legs), nymph (8 legs), and adult; sometimes each stage takes one year and is on a different host animal.
  - The egg, larval and nymph stages are often very small, making them difficult to see with the naked eye; several would fit on the head of a pin.
  - Adults are often bigger, but can range from a pin head to a nickel in size, depending if they are newly attached or full of blood.
- Each life stage, besides the egg, attaches itself to an animal or human, feeds on blood, then drops off to change or molt (3 host ticks) or remains attached (1 host ticks).
  - It is the blood feeding on different animals that causes disease spread.
- Three-host ticks molt on the ground in grass or areas with abundant vegetation.
  - Nymphs, larvae and adult ticks "quest" or seek out animals by climbing to the top of a blade of grass and latching onto the legs of animals that pass by.

Animals, pastures

- Cattle should be examined regularly for the presence of ticks.
  - Some ticks prefer to attach to the ears of cattle, others will attach to the groin and scrotum, while some can be found around the tail head and anus.
- Dogs and other small mammals can transport ticks and should also be examined.
  - To protect against certain species of tick infestation, there are topical products labeled specifically for monthly application in dogs; consult your veterinarian for more details.
- Keep pastures short by grazing or mowing to minimize vegetation where ticks could live.

Acaricides: products that kill ticks

- Many products are available; check with your herd veterinarian or local extension office for approved products in your area.
- Directly applied animal products
  - Many pour-ons or sprays are approved for use on food producing animals (read all label directions and apply accordingly) and are effective against certain types of body ticks.
  - Whole body dips are common for full coverage, but can be expensive and labor intensive.
- Insecticide cattle ear tags
  - Read all labels and apply accordingly (only specifically labeled ear tags are to be used with lactating dairy animals). One tag in each ear is recommended for ear tick prevention.
  - Work with your herd veterinarian to select the best impregnated ear tags for your cattle.

Tick removal and identification

- To remove a tick attached to an animal, apply slow steady pressure near its mouthparts with a narrow-tip tweezers.
  - Never squeeze an attached tick. If it is carrying a disease, this could enhance spread by injecting the tick's body fluids into the animal.
  - Humans can become infected with some tick spread diseases, so if you find a tick attached to a person, use the same removal technique. Leaving part of the tick embedded in the skin can cause an infection.
- Place the tick in a sealed container with a small piece of a damp paper towel.
  - Place the container in a sealed bag and give it to your local veterinarian or extension office for identification.
  - To make identification easier, only place the ticks from similar species (cattle, dog, human) into the same container.
  - Identification of ticks is important because they are small, many can look alike and different species spread different diseases.

It is a violation of state and federal law to use a pesticide in any manner that differs from the product label. Use only according to label directions to avoid meat or milk residue hazards, environmental damage, and animal or human injury.

Tick References:

- D.P. Furman and E.C. Loomis. 1984. The Ticks of California. University of California Publications, Bulletin of the California Insect Survey, Vol. 25. University of California Press, California.
- Kansas Insect Newsletter, Department of Entomology, Kansas State University, Gulf Coast ticks make their presence felt in Kansas accessed November 4, 2005 at *http://www.oznet.ksu.edu/dp_entm/extension/KIN/KIN_2005/kin-8/05ksnew8.htm*
- University of Nebraska-Lincoln NebGuide on Controlling Ticks published electronically August 1995 and accessed November 7, 2005 at *http://ianrpubs.unl.edu/insects/g1220.htm*

BIRD & RODENT CONTROL MEASURES

the Center for Food Security & Public Health
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Disease causing organisms can be carried on the fur, feathers or feet of some animals. Birds and rodents can spread diseases for a short time and distance and can also contaminate feed and water sources with their urine and/or feces. Control programs should be implemented to minimize their numbers and the risk of disease spread on your farm.

Eliminate openings for rodents or birds to enter, especially feed storage or processing areas.

- Seal any opening greater than ¼ to ½ inch with a durable material such as steel wool packed tightly into openings.
- Use materials that cannot be easily gnawed or pecked through such as concrete, sheet metal, wire mesh, aluminum or brick. Plastic sheeting, wood, rubber will not be adequate.
- Check openings around augers, pipes and wires. Use mortar, masonry or metal collars in these areas.
- Doors, windows and screens should fit tightly. The distance between the bottom of the door and threshold should not exceed ¼ inch.
- Drainage pipes or sewage systems may be used by rodents as routes to enter buildings. Equip floor drains with metal grates (openings less than ¼").

Remove potential hiding, resting and nesting sites.

- Equipment (e.g., refrigerators, powerwashers, etc.) should be raised and easily movable to allow for easy cleaning behind and underneath them.
- Sacked feed should be stacked on pallets with adequate space around and under them to allow easy inspection for signs of rodent activity and trap or bait placement.
- Rats can burrow and nest under feed bunks placed directly on the ground. Use of a concrete base around feed bunks can eliminate habitat.
- Maintain the water level in livestock waterers so it is deep enough that birds cannot stand in it.
- Hanging strips of heavy plastic vertically in doorways of buildings will allow machinery and people to pass through but keeps birds out. This will not prevent rodent entry.
- Cover the undersides of rafters with netting to exclude birds from nesting sites.

Eliminate potential food sources.

- Store feed in well sealed containers (preferably metal with tight fitting lids).
- Use covered feeders that exclude birds.
- Clean up any spilled feed immediately.

Proper disposal of garbage and dead animals is a very important part of rodent control.

Establish a rodent barrier around buildings.

- A 3 foot wide weed free area with a gravel rock perimeter can be used to prevent weed growth and discourage rodents from burrowing.
- Gravel (at least 1 inch diameter) should be placed in a band at least 3 foot wide and 6 inches deep.

Trapping is an effective way to control rodents.

- Proper placement of traps and baits is important. Set traps close to walls, behind objects, in dark corners, in places where rodent activity is evident.
- Use talc or flour patches to track where rodents are active.

Baiting may be used to control rodents.

- When using rodenticide baits, first read the label carefully and fully follow the directions.
- Use the amount of bait indicated on the package. Requirements differ between products.
- Protect baits from the weather.
- Be sure baits are not accessible to children, farm or domestic animals and birds.
- Inspect baits regularly. Check often for dead rodents and burn or bury those you find.

Other control measures are available, but beyond the scope of this document. Contact a wildlife pest control operator in your state for further assistance.

Check local legislation for allowable bird control measures. Many birds are protected by state and/or federal law.

For More Information

- Pierce RA. Bait Stations for Controlling Rats and Mice. University of Missouri Extension. *http://muextension.missouri.edu/explore/agguidees/wildlife/g09444.htm*
- Brittingham MC, Falker ST. Controlling birds around farm buildings. Pennsylvania State University Extension. *http://pubs.cas.psu.edu/FreePubs/pdfs/uh126.pdf*
- See T. Controlling rodents. North Carolina State University Extension. *http://www.thepigsite.com/Featured Article/Default.asp?Display=1015*
- Baker RO, Bodman GR, Timm RM. Rodent- proof construction and exclusion methods. University of Nebraska. *http://www.ces.ncsu.edu/nreos/wild/pdf/wildilfe/RODENT_PROOF_CONSTRUCT.PDF*